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THE GROSS EARNINGS OF 132 RAILWAYS for the month of March, according to *Bradstreet's*, are $33,570,319 on a total mileage of 83,492 miles, an increase of 4.9% in earnings and of 2.9% in mileage over the figures for the corresponding month of 1890. The increase has been quite general throughout the country. There have been no very large individual gains, but the number of gains, both large and small, is greater and consequently there are fewer decreases. Only 30 roads, or about one-fourth of the whole, show losses. Of these decreases the Central, Western and Granger roads furnish a large portion. The Eastern and Pacific roads show the largest increases, 12% and 11.4% respectively. The other groups show gains as follows: Southern, 7.4%; Trunk lines, 5.3%; Southwestern, 3%, and Central Western, 2.7%.

A MOTOR CAR, capable of hauling several trailing cars of the usual size, has been designed by Mr. F. S. PEARSON, the electrical engineer of the West End Ry., in Boston, Mass. The tests of the motor have recently been begun, and it is hoped that the car will prove sufficiently powerful to handle large crowds, such as those attending ball games, without the usual delay.

A NEW HIGH-POWER POWDER, made by the Du Pont Powder Works, has been tested with much success at the Annapolis proving ground. It gave an initial velocity of 2,130 ft. a second with a pressure in the powder chamber of but 14.8 tons per sq. in. The average powder now used gives only 2,080 ft. per second with a chamber pressure of 15 tons.

THE LARGE STEEL DRAWBRIDGE over the Arkansas River at Fort Smith, Ark., was successfully tested April 9, by running a train of four mogul locomotives over it. The bridge is 2,370 ft. long and consists of 12 spans, out of which is a draw span 370 ft. long. It was built on the system designed and patented by GEO. H. PEGRAM, consulting engineer of the Missouri Pacific Ry., illustrated in ENGINEERING NEWS, Dec. 10 and 17, 1887. The structure will carry both highway and railway traffic. Work was commenced on the substructure in January, 1890 and upon the superstructure in October of the same year. The Union Bridge Co., of New York City, had the contract for the superstructure. The bridge will be opened for railway traffic at once and for highway traffic in about six weeks.

THE PORT ORCHARD, WASH., DRY DOCK will be 600 ft. long, 70 ft. wide and capable of taking a vessel of 30 ft. draft, according to Lieut. A. B. WICKOFF, the naval officer at present in charge of the work.

THE MOST SERIOUS RAILWAY ACCIDENT of the week was a rear collision on the Delaware & Hudson road between Worcester and Cobleskill, N. Y., April 13. A fast freight train ran into a gravel train, wrecking the caboose of the latter, in which were 5 Italian laborers. Two of the men were killed by the collision, and the other 3 were caught in the wreck and burned to death. The freight engine and several box cars were wrecked. An express train on the Cleveland & Pittsburg R. R. ran into a landslide at Vanport Pa., April 13. The entire train was derailed, and some of the cars were thrown down the bank. Three men were seriously injured. A serious derailment on the Louisville & Nashville R. R. near London, Ky., on April 10, was caused apparently by the carelessness of section men. They had removed a broken rail and laid a new rail, but had not spiked it when the train came. The engine passed over, but the baggage and smoking car and 2 passenger cars were derailed and overturned. One person was killed and 2 were seriously injured.

THE MILL CREEK BRIDGE of the Cincinnati, Hamilton & Dayton R. R., between Carthage and Hartwell, O., was burned this week. It was a double-track covered wooden bridge, 100 ft. long, and was set on fire by sparks from a locomotive. The trestle approach at the north end was saved.

A DAM in the Kennebec River, at Waterville, Me., was partly carried away April 13. A dam at Nichols Pond, near Baldwinsville, Mass., gave way April 13, and the flood caused a washout on the Fitchburg R. R. Mr. SAMUEL BACHTELL, Chief Engineer of the State Board of Public Works at Columbus, O., asks us to make a correction of the item on page 337 concerning the breaking of the Mercer Co. or Grand reservoir. He says: "The banks have not broken, nor was there any damage done to any property excepting to some crops flooded in a few instances. The banks have been somewhat washed by the action of the waves, where the rip-rap had been removed by frost and other causes."

WOULD-BE INVENTORS OF COUPLINGS FOR STEAM CAR HEATING should peruse for their discouragement a circular just issued by the Consolidated Car Heating Co. According to this, the perfect steam coupler should be: 1. Steam tight. 2. Uncouple automatically. 3. Not rotate on gaskets or steam joints. 4. Have a straight and unobstructed passage for steam. 5. Have no traps, springs, rocking cams, diaphragms or other movable parts. 6. Hang below air coupling. 7. Have projections from general outline of coupler as far as possible, and these not likely to break. 8. Be compact in form. 9. Be absolutely interchangeable, whether old or new, each half being an exact counterpart of any other half of its kind, and wear must not affect this interchangeability. 10. Be not expensive in first cost or repairs. 11. Be simple in construction and quickly and economically repaired. 12. Be easily coupled and uncoupled. The company claims that its own coupler meets all these conditions, and, if so, there seems little more to be desired.

THE QUESTION OF A PURER WATER-SUPPLY FOR PHILADELPHIA seems likely to be brought up again by the present epidemic of typhoid fever in that city. In the first three months of the present year there were 910 cases of typhoid fever, and 196 deaths from that disease. The greatest mortality is found in the four wards that use the water supplied directly from the sewage-polluted water of the Schuylkill River. The population of these wards is 184,000, and there have been in three months 317 cases of typhoid and 42 deaths. This great mortality is especially noticeable because the population of these wards is of the well-to-do class and the district is elevated and well drained. A similar but less severe epidemic of typhoid was pervalent in 1889, and at that time the greatest mortality was in the wards which secured their supply directly from the Delaware River at the Kensington wharves. The source of supply of this district has since been changed, and very few cases of fever are reported.

STATISTICS OF RAILWAY CAR HEATING are published in the last issue of the *Railway Review*. They cover 33,772 cars, on railways of the United States, Canada and Mexico, of which 9,017 are heated by steam from the locomotive, 9,118 are heated by hot-water heaters, 11,612 are heated by stoves and 1,025 (summer cars and cars on Southern roads) have no heating apparatus. Statistics published by ENGINEERING NEWS on June 7, 1890, showed 7,391 cars equipped for heating by steam from the locomotive.

According to these figures, the increase in the number of steam-heated cars since last spring has been 1,626. The reform ought to go ahead a great deal faster than this. Steam car-heating is likely to be made compulsory by legislation, now that its safety and practicability are thoroughly proved, unless the railway managers who are neglecting this reform awake to their duties.

THE BOYCOTT OF PASSENGER TICKETS issued by the Chicago & Alton R. R. Co., inaugurated by the principal Eastern railways, has gone into effect. The boycott arises out of the refusal of the Chicago & Alton R. R. Co. to join in the agreement of the principal railways, both in the East and West, to abolish the practice of granting commissions to ticket agents on passenger traffic. Thus far only the Eastern roads belonging to the association have actively entered the boycott; the Western roads being involved only in so far as the sale by them of tickets to Eastern points is concerned. Whatever the outcome of the action may be, it does not detract anything from the culpability of the Chicago & Alton Co. in opposing a reform so much to be desired.

GRADE CROSSINGS at Elizabeth, N. J., are at last to be really abolished, after years of talk. The Central R. R. of New Jersey will lower Union St. to pass under its line. The tracks will be raised 1 ft. and the street depressed about 13 ft., with grades of 3½% on each side. There will be a four-track through plate-girder bridge with a clear span of 50 ft. between abutments. The work is in charge of Mr. J. H. THOMPSON, Engineer of Construction. The Pennsylvania R. R. has also let contracts for lowering the streets to pass under its tracks, and it is stated that work will be commenced on the elevation of the line from North Elizabeth to South Elizabeth, and on the construction of a new station.

A GEOLOGICAL SURVEY OF NORTH CAROLINA will begin shortly, the Legislature having decided to appropriate $10,000 annually for that purpose. Prof. J. A. HOLMES, of the North Carolina University, has been appointed chief officer of the work.

THE SABANILLA AND MAGDALENA CANAL, in the United States of Colombia, is to convert the bay of Sabamilla with the Magdalena River near Barranquilla. A concession was granted to Mr. M. A. FONSACA in November, 1890. The canal will be 5 to 10 miles long, 65½ ft. wide, and 10 ft. deep. A recent consular report states that it will be in competition with the Bolivar Railway, from the bay to Barranquilla, a distance of 18 miles. The railway freight rates are from $1.25 to $5.40 per ton for this distance, and the canal rates are not to exceed 25% of these rates.

THE CORPUS CHRISTI & SOUTH AMERICAN RAILWAY CO., organized early in 1890, has completed the surveys for its proposed railway from Corpus Christi, Tex., south through Mexico and Central America, and maps of the route are now being prepared. The route, as described by General Superintendent WM. DAVIS, will be from Corpus Christi to Brownsville, Tex., thence south to Tuxpan, Manitilan and Tehuantepec, Mexico, and thence through Guatemala, San Salvador, Nicaragua, Costa Rica and Panama, a total distance of 2,150 miles. According to the surveys the work will be easy, with the exception of about 150 miles in Mexico, where the ascent is made from the coast to the central plateau. Mr. DAVIS states that the entire line will be put under construction at once and the line completed within three years. The scheme is undoubtedly an outcome of the recent Pan-American Congress advocating an inter-continental railway and is devised principally for speculation purposes.

The Comparative Merits of Various Systems of Car Lighting.

I.

As we have intimated in prior issues of this journal, we have been collecting for some months past the material for a short series of articles on the comparative merits and demerits of the various systems of car lighting, of which there may be said to be only three of much present prominence for general use, viz.:

1. Oil lamps.
2. Compressed oil gas.
3. Air gas generated from gasoline.

Electric lighting is as yet too dear, and candles are both too dear and too poor an illuminant to enter largely into the immediate practical question. Compressed coal gas is used by only one company, and not approved by it. Nevertheless we shall give some details as to these also.

The primary question with regard to any and all systems of car lighting must be, How much effective light is obtained from it for a given quantity of combustible? This part of our investigation was undertaken by Mr. W. B. D. PENNIMAN, Chemist of the Baltimore & Ohio Railroad, known to us as an expert in such matters, who kindly arranged to give the very considerable time required for some careful photometric tests, as he could spare it from his other and regular duties.

These tests he has at last completed, after some unavoidable delay, and our readers will agree with us that they constitute the most complete evidence on this subject which has as yet appeared.

Mr. PENNIMAN has also given us the benefit of his counsel and assistance in collating and digesting the records generally, which his intimate practical knowledge of the subject has enabled him to do most effectively. For the correctness of the photometric and chemical tests, however, he is alone responsible, and for all the remaining facts and opinions this journal is responsible.

In the meantime, Mr. GEORGE GIBBS, Mechanical Engineer of the Chicago, Milwaukee & St. Paul Ry., has prepared and read a valuable paper on the subject of car lighting (republished in ENGINEERING NEWS for March 7-14, 1891), which in a measure covers the same ground as that which we have proposed to cover. In part it more than covers it, and in part falls short of doing so, as is but natural, and, as in some respects his results are discordant from those which we have reached, we shall include the data in his paper with the rest of our material, point out the points of agreement and difference, and thus, we hope, make both his records and our own more valuable. Some of the points of difference are of much importance.

The question of car-lighting methods naturally divides itself into these sub-heads:

1. The nature of the illuminant.
2. Comparative photometric efficiency.
3. The construction and cost of the plant.
4. The cost of operation, maintenance and renewal.
5. Comparative safety and convenience.

We shall consider the subject in this order.

THE NATURE OF THE ILLUMINANTS.

The illuminants used for all three of the chief systems of car illumination are products of the distillation of crude petroleum, the Pintsch and other oil gas systems,* making a permanent gas from crude petroleum or some of its products; the oil lamps using some one of the kerosene oils, which range from 110° to 150° Fahr. fire-test for the ordinary household oil to the "mineral sperm" or 300° fire-test oil, the last the only one ordinarily used, and the only one which the law of most states permits to be used for lighting passenger cars; and the carbureter system using a gas formed (*i. e.*, supposed to be formed) by passing air through gasoline and charging it with its vapor. As a matter of fact, however, this gas would seem from the records below to consists chiefly of the vapor or steam of gasoline heated above its boiling point (110° F.).

*There is at present no other system of oil-gas lighting before the public but the Pintsch, which is controlled by the Safety Car Heating & Lighting Co., of 160 Broadway, New York. There was formerly another, organized by Mr. J. M. FOSTER, and known as the American Lighting Co.; but this company is now out of business, so far as we are informed. It is claimed that their method of manufacturing gas was less perfect than the Pintsch, and some accidents to their gasworks on the Reading and other roads have been erroneously supposed to have been accidents to Pintsch works.

In order that the photometric tests may be properly interpreted, a few facts as to the nature of crude petroleum and its products may be given now better than later.

All petroleum hydro-carbons are irregular chemical mixtures of the following so-called paraffine series, the general formula for which is $C_n H_{2n+2}$, no one of which series is ever found (in the liquid hydro-carbons) separate from the rest, nor can it be obtained from them by ordinary processes of distillation:

	Boiling point.
Methane .... C H_4 (Marsh gas)	Gas
Ethane ..... C_2 H_6	"
Propane ..... C_3 H_8	"
Butane ..... C_4 H_{10}	1°
Pentane ..... C_5 H_{12}	38°
Hexane ..... C_6 H_{14}	70°
Heptane ..... C_7 H_{16}	98.4

and so on down to $C_{24}H_{50}$ in paraffine.

The upper compounds of the series are gases, then highly volatile liquids, followed by liquids of greater weight and lower boiling point, and finally by solids. The series is even more complicated in practice than it appears above, as all the single compounds below $C_4 H_{10}$ (butane) have (or may have) one or more substances of the same formula but entirely different properties, boiling point, etc. The single compounds have been prepared in some cases,

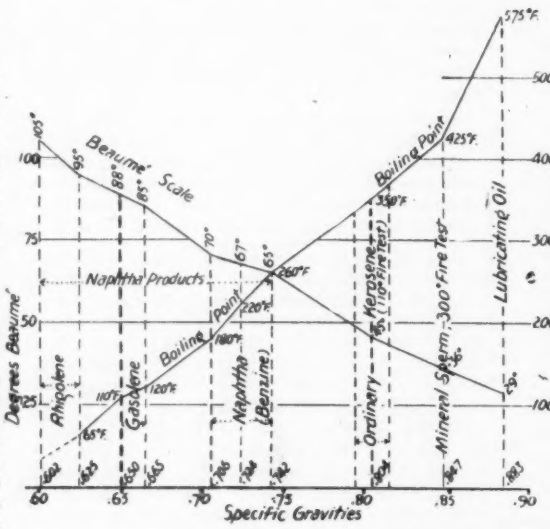


FIG. 1. DIAGRAM OF CERTAIN PHYSICAL PROPERTIES OF THE VARIOUS COMMERCIAL DISTILLATES OF CRUDE PETROLEUM.

but the process is often slow and difficult. All the members of the series, however, are characterized by a remarkable chemical indifference, and are unaffected by mineral acids and alkalis which, in practice, are used to effect their separation from other substances. The complication of the series given above is much increased by the fact that there are other substances which belong to this series of the formula of $C_5 H_8$, the molecular construction of these is represented thus:

$$CH_2 \begin{cases} CH_2 \\ CH_2 \end{cases}$$

All the chemical compounds in the series below propane, moreover, may make different substances. For example, there are two butanes, three pentanes and six hexanes. In the process of distilling crude petroleum, which is made up of an inconceivably complicated mixture of various elementary compounds named above, those near the top of the list are driven off first, and it is possible to obtain a distillate of any desired specific gravity between 0.60 and 0.90, and of any desired boiling point between about 60° and 606° Fahr. by varying the process of distillation; but no one of these distillates can be made to contain any one or two of the series only. It will contain many of them, and its physical properties will be determined by its average composition or average place in the series. The ordinary commercial products obtained by distillation from crude petroleum with their boiling points, fire-tests, specific gravity, and density, by the Beaumé scale, are thrown graphically in the accompanying Fig. 1, and in more detail in the following table, which also gives the proportion of each product which ordinary crude petroleum affords:

PROPERTIES OF THE VARIOUS COMMERCIAL DISTILLATES OF CRUDE PETROLEUM.

	Specific gravity.	Beaumé test.*	Boiling point, Fahr.	Fire test, Fahr.	Per cent. of total product.
Rhigoline	.602 .625	95°@105°	65°	..	in-sig't
Gasolines:					
For carbureters	.65	88°	110°	....	.07
Ordinary	.665	76°	120°	..	1.3
Naphthas:					
C For street lamps, etc	.706	70°	180°	....	8.0
B For sponge lamps	.721	67°	220°	....	2.5
A Benzine	.742	62°@65°	260°	....	2.5
Tot'l of "naphtha prod'ts"	....	....	....	....	15.0
Kerosene oil	.804	45°	350°	110°	70.0
Mineral sperm oil	.847	36°	425°	300°	10.0
Lubricating oil	.883	29°	575°	..	5 0
Paraffine wax	.848	....	....	....	
Solid residuum	....	....	....	....	
To'l of m'k'table products	....	....	....	..	100.0

Loss in producing from crude petroleum, say, 10%.

Various other intermediate products are manufactured, for, as we have said, an oil of any gravity desired, within the limits of the above table, can be had by varying the process of distillation. Thus, the oil commercially known as "signal oil" is of about 250° fire test, and the commercial "headlight oil" is of 175° test, and both are largely used. Therefore, it is natural that the percentage of the various products should vary somewhat both with the crude oil and the demand for the several products, but the above is about the present average of the United States as nearly as we can ascertain, and it can be varied only within narrow limits. Formerly the percentage of the gasoline products was less, and of kerosene greater.

The government statements of petroleum exports have on them the following standing announcement, from which it would appear that the percentage of the lighter petroleum products is not so large as above estimated:

It is stated on good authority that the distillation of 100 galls. of crude petroleum will yield 76 galls. of illuminating oil, 12 galls. of gasoline, benzine or naphtha, 3 galls. of lubricating oil and 9 galls. of residuum.

The present crude petroleum product in this country may be taken as about 30,000,000 bbls. (of 42 galls.) as a maximum, of which about half is now from Ohio and other outlying fields. This product has been increasing very slowly indeed since 1880, when it was 26,286,123 bbls., the increase prior to that time having been very rapid. The average wholesale prices of refined petroleum and of naphtha in cents per gallon in New York have varied about as follows:

Year,	1881.	1882.	1883.	1885.	1887.	1888.	1890.	1891.
Petrol'm.	8.0	7⅛	8)	8 0	6¾	7⅛	7¼	7.0
Naphtha.	...	...	5½	7⅞	7⅛	7¼	7.85	8.0

At the present time about 12,000,000 bbls. of petroleum per year are exported, chiefly in the form of refined oil, the price of which is but a small fraction of a cent above the crude.

The quantities of these several products, which are now produced or producible in the United States may be approximately stated as follows:

	P. c. of total product.	P. c. of crude oil.	Bbls. of 42 galls. per year.	Present value per gall. cts.
Gasoline of 88° proof	0.7	0.63	189,000	15.
" 76° to 85° "	1.3	1.17	351,000	....
Naphthas	13.0	11.60	3,510,000	8.
Kerosene oil	70.0	63.00	18,900,000	7.2
Mineral sperm oil	10.0	9.00	2,700,000	9.2
Lub. oil, etc	5.0	4.50	1,350,000	....
Waste in refining	....	10.00	3,000,000	....
Total crude oil product, say,	100.00		30,000,000	6.83

All the above products are now merchantable products, and in large demand. As may be inferred from the fluctuations of price given above, the use of the naphthas and gasolines, especially (which were formerly in large degree waste products), has now greatly extended, so that their price ranges consid-

*The Beaumé scale is the reading of the so-called Beaumé hydrometer, which reads 0° in water saturated with 10% of pure salt, and 10° in distilled water at 51¼° Fahr. (10° R.); 20° B. = .928 sp. gr., 30° B. = .867, 40° B. = .817, and so on up to 100° B. or more, as shown in Fig. 4. The Beaumé scale for fluids heavier than water is different, starting with 0° in distilled water, and running up to 72° B. for 2,600 sp. gr.

erably higher than the heavier and more abundant products. As will be seen more fully later, to supply all the passenger cars in the United States with gasoline for lighting uses would require an average of 450 bbls. (of 42 galls.) per day, or 164,250 bbls. per year, to which add 20% for wastage, and the total becomes 197,100 bbls., or somewhat over the possible total product.

The chemical nature of the fixed gas (oil gas) produced by the destructive distillation of crude petroleum we need not now stop to consider, since its composition does not vary with momentary conditions. The nature of the gas produced by passing air through gasoline, however, varies greatly with the surrounding conditions, and must be briefly indicated.

The so-called "vapor tension" of gasoline, *i. e.* the proportionate quantity of the spirit which can exist dissolved in air or other gas, and be pemanently retained therein without being deposited in a fluid condition, varies greatly at different temperatures below its boiling point of 110° to 120° Fahr. According to figures given in KING'S "Treatise on Coal Gas," which is an elaborate and standard work, it is such as to permit the following percentages of gasoline to be thus retained at different temperatures:

Percentage of the Vapor of Gasoline (88° B.) which can be retained in Air at Different Temperatures:

Temperature of air.	Per cent. of gasoline retained.
14° Fahr.	5.7
32° "	10.7
50° "	17.5
60° "	22.0
68° "	27.0
104° "	39.0

These percentages are shown graphically in the the accompanying diagram (Fig. 2), from which it

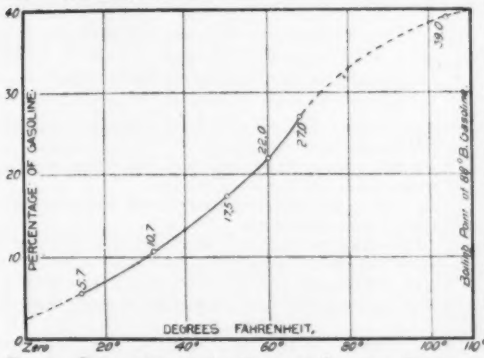


Fig. 2. Percentage of the Vapor of Gasoline Retainable by Air at Various Temperatures.

will be seen that about 40% of gasoline is the utmost which can be said to be carried off or dissolved in air below the boiling point of gasoline. Above that boiling point (110° F.) the gasoline is converted into steam, and any percentage whatever may be mingled with air. As already stated, and shown more fully later, it would appear from our tests that in the gas produced in practice by the so-called carbureter system the relative quantity of air to gasoline is many times less than the above table calls for.*

What further details are of importance in reference to the nature of the illuminants we shall more conveniently reach later.

Is the General Use of Water Meters Remunerative to the Owners of Water-Works?†

The writer is of the opinion that the water meter should be generally used for the purpose of measuring out water by water-works managers to their consumers. To enable him to concisely present his views upon this question, the writer suggests three distinct objections to what is commonly known as the "Schedule Rate" system of charges for water as distinguished from the "Meter System."

These three objections to the "Schedule Rate" system are as follows: Its results are unsanitary; it is unjust in its operation; it is liable to result in financial loss to owner or consumer.

SANITARY CONSIDERATIONS.

In relation to the first proposition, it may be stated, that 20 years ago it was the practice of hydraulic engineers in designing a new system of water-works, to provide for a supply of 60 galls. per day, per capita of the estimated population at the end of 15 to 20 years.

As a result of the habit of enormous waste which has grown up, and has been fostered by the practically unrestricted "Schedule Rate" system, the practice of the hydraulic engineer of to-day is to provide a supply of at least 100 galls. per day per capita, and many conservative men in the profession believe that a safe provision is not less than 150 galls. per day, and this opinion is fairly sustained by a collation of the data in relation to the amounts used in various cities in this country at the present moment. Within a few months, but for another purpose, the writer had occasion to collect from first hands the following statement of the quantity of water used per capita daily in the following named cities:

Toronto, Ont.....131 galls.	Buffalo, N. Y .....170 galls.
Milwaukee, Wis....110 "	Springfield, Mass.....91 "
Detroit, Mich.....148 "	Cleveland, Ohio.....98.7 "
Troy, N. Y.....170 "	

The author then proceeeded to argue that this excessive use of water made the work of sewage purification and disposal far more costly than would otherwise be the case, and in fact acted as a general barrier to the establishment of sewage disposal plants.

THE INJUSTICE OF THE SCHEDULE RATE SYSTEM.

Concerning this, Mr. TUBBS said that the relation is very remote between the amount of water used in a house for domestic purposes and its width, height, number of rooms or even number of faucets. When users of water may waste it at their pleasure, the owner must make schedule rates so high that they are burdensome and unjust to the honest and conscientious user of water.

Mr. TUBBS considered that the meter should be furnished and maintained by the works. Their cost should be considered a part of the cost of the works, and one should be supplied to every service taking water therefrom. The rates charged should cover the cost, depreciation, interest and profit, on the meter.

LOSSES BY THE SCHEDULE RATE SYSTEM.

The author gave the average daily consumption per capita under the schedule rate system at 100 galls. Under the system in which the whole or a large percentage of the services are metered, the consumption does not exceed, on the average, 50 galls. per day. He concluded, therefore, that a given supply would be outgrown by a town twice as soon under the schedule rate system as under the meter system, and that the saving would be determined largely by the cost of extending or duplicating the original works, which would be necessary under the schedule rate system.

To illustrate this method of computing the saving by the use of meters, the author assumed the following case:

Present population of a town is	5,000
Estimated population at end of 20 years	10,000
Yearly increase of population	250
Total capacity of the works per day in gallons	1,000,000
Daily use per capita, in gallons, when operated under a "Schedule Rate" plan	100
Daily use per capita under the meter plan	50
Estimated number of users to each service	5
Original cost of works	$100,000
Average cost of each meter, with setting	$18
Average yearly cost of repairs to each meter	$0.32
Yearly interest on each meter and cost of setting	$0.90
Average life of each meter in years	12
Yearly rate at which interest is compounded	5%
Number of services attached and meters used each year	100

On the basis assumed in the foregoing, at the end of 20 years there will be 2,000 meters in service as follows:

4-in. meters,	10, at $200	$2,000
3-in. "	20, at 100	2,000
2-in. "	30, at 60	1,800
1½-in. "	40, at 40	1,600
1 in. "	100, at 25	2,500
¾-in. "	200, at 20	4,000
½-in. "	1,600, at 13	20,800
Total...2,000		$34,700
Or an average for each meter of		$17.35
Add for setting		.65
Total cost of each meter and setting		$18.00

The cost of meters may then be represented as follows:

Amount to be placed at compound interest each year for each meter at 5%, so that the several principals and interests will together equal the original cost of the meter and its setting at end of 12 years	$1.06
Yearly interest on cost of each meter and its setting	.90
Yearly cost of repairs for each meter	.32
Amount to be placed at interest each year for each meter, so that at end of period a fund equal to the whole charges on account of meters shall be accumulated	$2.30

The author computed that at the end of 20 years the consumption would have reached the capacity of the works under the schedule rate plan. At that time if the meter plan has been in use, as before stated, 2,000 meters will have been set, and the consumption will still be not above half the capacity of the works. On the basis of a total cost of $2.30 per year per meter, the total expended for meters will be $71,136. If the cost of the meter is collected from the consumer, it will cause an addition to the water rate of about ¼ ct. per 100 galls. used. If the water has to be pumped, there will be a greater saving as follows:

The cost of pumping for small works, like those in question, may be taken at $9 per 1,000,000 galls., raised 150 ft.

Average daily pumping on the "Schedule Rate" plan equals 500,000 galls., at $9 per million galls., 150 ft	$4.50
Average daily pumping on the meter plan, 225,000 galls., at $9 per million galls, raised 150 ft	2.25
Daily saving on the meter plan	$2.25

The saving of $2.25 daily for 20 years, together with compound interest on the several yearly savings, would amount to $25,414, and would thus reduce the meter account for the same period from $71,136 to $45,722.

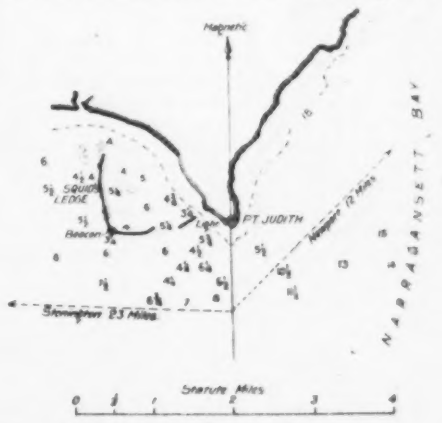
The author called attention also to the following inducements for the use of meters.

In the original construction of water-works the cheapest and most available source is usually selected, and in very many cases the provision made requires all the water which that particular source will furnish, so that when the time arrives for duplicating the amount of water to be furnished, more distant sources must be sought, involving large preliminary expenditures, often in excess of the original cost. In such cases it can be readily seen that the general use of meters, by which the time for which the original provision is adequate is indefinitely prolonged is the cheaper plan.

The tendency of demand is toward the production of a cheaper meter. Inventors all over the world are engaged in attempts to produce a meter which shall combine *cheapness* with accuracy and durability. Insomuch as they are successful in this, to that extent also will the financial economy of the meter system be manifest in the future.

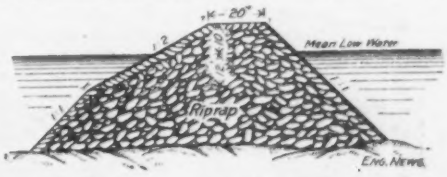
The Harbor of Refuge at Point Judith, R. I.

The River and Harbor Act of Sept. 19, 1890, provided for the commencement of the construction of a harbor of refuge near Point Judith, R. I. This point is at the southwest entrance to Narragansett



Plan Showing Position of Breakwater.

Bay and is exposed to all but northerly winds. The nearest points of land are Block Island, about 12 miles south, and the eastern end of Long Island, about 25 miles to the southwest. On



Cross-Section of Breakwater.

the southeast it is exposed to the full force of the waves from the Atlantic.

The southerly winds, taken in connection with a meeting of the tides flowing westerly from Buzzard Bay, southerly, from Narragansett Bay, and easterly from the sound, cause a particularly bad sea in this locality, so that the proposed harbor of refuge will,

* The percentage of gasoline to air in the ordinary fixed gasoline gas plants is about as the above diagram (Fig. 2) calls for. Thus, in some extensive and unsuccessful experiments in London, made by an "Air Gas Co." in 1872-74, as detailed in KING'S "Treatise on Coal Gas," 1,000 cu. ft., or 76.5 lbs., of air was charged with 4 galls., or 21.76 lbs., of 88° gasoline, or 28½ %, the temperature being about 70° F., and the resulting candle power for 5 cu. ft. per hour about 16 c. p., but the loss of illuminating power was very great as the temperature fell, a fall of 20° resulting in a loss of about one-third of the illuminating capacity. In absorbing the gasoline the 1,000 cu. ft. of air expanded to 1,109 to 1,200 cu. ft., whence it gave 240 hours of 5 cu. ft. and 16 c. p. flame, whence the c. p. hours per lb. of gasoline were 176.7, and per oz. of gasoline 11.04, which we will compare with other records later.

† Condensed from a paper by Mr. J. NELSON TUBBS, read before the American Water-Works Association.

doubtless be appreciated by those interested in the extensive commerce passing the point.

The accompanying sketch shows the approximate location of the proposed breakwater. The western arm of the main breakwater will be built on "Squid Ledge," which runs nearly north and south, and is about 1½ miles west of the Point Judith lighthouse. This ledge offers an excellent foundation for the work in a depth of from 18 ft. to 24 ft. of water. The breakwater will be built of rip-rap, and will be 20 ft. wide on the top, which will be 10 ft. above mean low water. The outside or sea slope will be 1 to 2 to a depth of 12 ft. below mean low water, below which plane the slope will be 1 to 1; the inside or harbor slope will be 1 to 1. The stone for the work, at present, will be brought from the quarry operated by the government on Mason's Island, Mystic River, Conn., requiring water transportation of about 28 miles.

The first steps in actual construction were taken on Feb. 12, when a temporary light was established to mark the southwest angle of the main work, and serve as a beacon, warning passing vessels to keep to the south to avoid striking the stone of the incomplete work. The frame for the light was made by framing four 12 × 12 in., yellow pine sticks, 30 ft. long, firmly together in the form of a pyramid. This frame was carried on a steam lighter to its location. It was launched by the lighter's derrick, and about 600 tons of stone were piled around it to hold it in place. The light was suspended near the apex, at a point about 20 ft. above the water. This beacon has already stood several hard storms without injury. The breakwater will be extended both northerly and easterly from the beacon with a view to securing some protection to the harbor as soon as possible. The work is in charge of Major W. R. LIVERMORE, U. S. Engineer, with Mr. EDWARD PARRISH as Assistant Engineer.

Computing Areas from Cross-Section Notes.

We have received from a correspondent and old subscriber an article under the above head, which we give below in full, relating to certain alleged simplifications in the process of computing earthwork. The article has suggested to us that it may perhaps be of service to many of our readers to show in a practical way, by numerical examples, what are the actual limits in the way of the simplification of such processes by means of the system of diagrams devised some years ago by Mr. A. M. WELLINGTON, of this journal, and ever since in quite extensive use, although by no means in such extensive use as it is desirable that they should be, since at one and the same time they save almost the whole of the otherwise tedious labor of numerical computation, and afford a higher degree of accuracy and precision than is practically possible with any amount of labor with paper and pencil. That these possibilities are not as well understood and as generally known as they should be, our correspondent's letter clearly shows. We therefore give in full what he suggests, and will afterward endeavor to show him and others "the more excellent way."

To Compute Areas from Cross-Section Notes by Rectangular Coördinates.—The old method of calculating areas from cross-section notes by considering the area included between two adjacent readings and grade as a trapezoid, though perfectly correct, is exceedingly slow and laborious where many readings are taken. After the computations are made, at the ends there must be taken from the result two triangles, unless the end happens to be at grade. Now, whatever the method used for computing quantities from the notes the areas are invariably the first thing sought. In view of this fact it would seem that any method which lessens labor, is easier, and is just as accurate, would recommend itself at once to those who have this problem to deal with.

Since we have the distance out from the center and the height above or depth below grade, we have the abscissas and ordinates respectively of every point around the figure. Hence we can compute the area at once by going around the figure represented by plotting the area, as given by the notes. Let us take a sample of field notes and plot them as in Fig. 1, to make the meaning clear.

L			C		R	
−9.8	−0.8	0.0	+4.0	+5.2	+9.0	+6.0	+6.0
22.7	12.0	3.6	0.0	3.2	8.0	15.0	19.0

We will consider the roadbed 10 ft. wide in cut and 8 ft. in fill from the center at grade. Let the slope be 1½ to 1.

Now, if we take the ordinate of the center, which is as convenient a place to begin as anywhere, and multiply it by the difference of the two adjacent abscissas, and so go on around the figure, making the subtraction always in the same direction, the figure will stand thus:

4.0 × (3.6 + 3.2) = 27.2	8.0 × (22.7 − 3.6) = 152.8
5.2 × (8.0 − 0.0) = 41.6	9.8 × (8.0 − 12.0) = −39.2
9.0 × (15.0 − 3.2) = 106.2	
6.0 × (19.0 − 8.0) = 66.0	2)113.6
6.0 × (10.0 − 15.0) = −30.0	Area of fill = 56.8
2)211.0	
Area of cut = 105.5	

The result is the algebraic sum, and is the difference, of course, of the minus and plus quantities.

The reason we took next to the last abscissa, or distance out, from 10 and 8 ft., is because those were the next points in following around the figure outward from the centre. As we use the ordinates, or elevations, for a multiplier, any grade point is not to be multiplied by the difference of abscissas, since 0.0 multiplied equals zero. This also serves to separate cut from fill. The abscissas could have been used in place of the ordinates, and *vice versa*, but this plan is far better, since cut and fill are always divided, or should be, by a grade point and reading. The result of the multiplications is always twice the area. If more convenient, we could divide one of the factors before multiplying, but results are far more trustworthy where the mind is not kept on too many things at once. In order to be sure and subtract from the right number, we could, until accustomed to this way of thinking and computing, write the width of roadbed at end of the notes, as above. We add 3.6 and 3.2 because they are that distance each side of the center, or 0.0, and their sum is the difference between those two points.

Now, if we will notice the notes and observe just how and in what order the figures are taken, as indicated by lines, it will be seen to be much simpler than the figure. But the figure is necessary, so as to fix in the mind the how and why of this process. Indeed, in calculating where it has been re-cross-sectioned, it is absolutely necessary.

This method will calculate any areas, and is the simplest solution of the problem in general, except where the surface of the ground is a dead level transversely, which is not a very frequent case. A demonstration of the principle involved will be found in Johnson's Surveying.

We will sum up with the following rule:

Multiply each ordinate (cut or fill) by the difference of the two adjacent abscissas (distances out), and take one-half the sum of the products.

Note I.—When the adjacent abscissas are on each side of the center, add instead of subtract.

II.—The abscissas at the ends are the width of cut or fill for road bed at grade.

III.—Each problem (or area) stops at grade, like the cut or fill, since 0.0 + any quantity = 0.0.

IV.—When the last elevation next to the slope is farther out than the edge of roadbed at grade, it gives a minus quantity, which is to be subtracted; ∴ when this reading can be taken directly over the edge of the road bed, the calculations are shortened and simplified.

V.—When cross-sections are taken the second time, as in borrow pits, omit the superfluous notes and go around the figure representing the difference of areas, always making the subtractions in the same direction; the + and − quantities should be kept separate, and half their difference is the area required. If both cut and fill are in the notes, it does not affect the difference of areas. Proceed just the same.

Now, without stopping at present to criticise this method, let us first note what remains to be done after the areas are thus computed, and then see how the same work may be done by a "Diagram of Triangular Prisms" (Fig. 2) without any numerical computation whatever in most cases. Each of the seven separate products shown above has first to be obtained and their sum divided by two for each section. The sectional areas thus determined are then to be added to the corresponding ones for the next section, divided by 2, and the quotient divided by 27 to give the "end area" volume of the solid. In some cases the labor of dividing by 27 is saved by reference to a table, and a few men learn to divide by 27 by short division, as all engineers should learn, since it soon becomes easy enough.

A diagram of triangular prisms saves practically all this work. It consists in its complete form of a

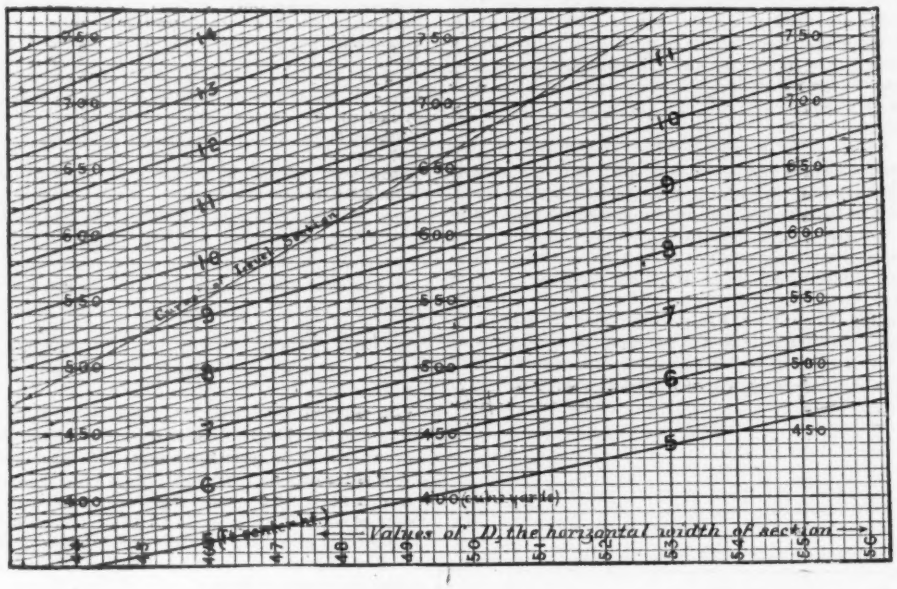


FIG. 2. EXTRACT FROM "DIAGRAM OF (THREE-LEVEL) CROSS-SECTIONS," FOR ROADBED 18 FT., SLOPES 1½ TO 1; FROM WELLINGTON'S "COMPUTATION OF RAILWAY EARTHWORK."

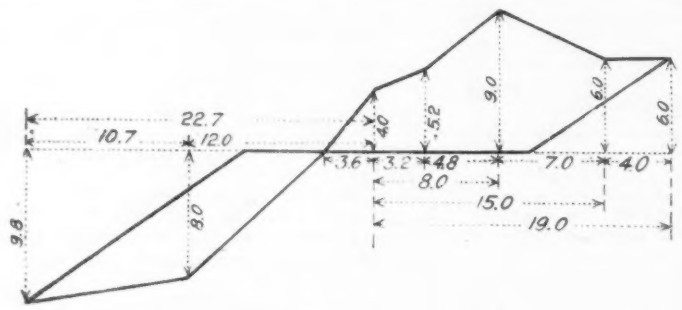


FIG. 1.

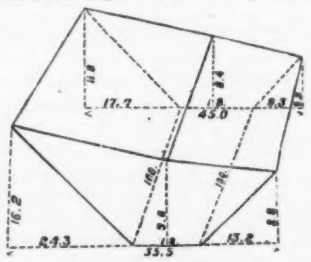


Fig. 3.

sheet about 14 × 17 ins., which gives at a single inspection all possible values of the equation

$$Q = \frac{100}{54} c\, w$$

for values of c from 0.1 to 18.0 ft. and for values of w from 0.1 to 88.0 ft. The extract which we give in Fig. 5 (neglecting the upper part, where the figures are seen reversed, which we need not now consider) gives the values of Q corresponding to values of c, from 0.1 to 18.0 ft., but for values of w, ranging from 21.0 to 33.0 ft. only. To see how this diagram is used to compute such sections as that shown in Fig. 1, we will first take up the simpler and (on railway earthwork) more common case of a "Diagram of Cross-sections," Fig. 2, used for computing ordinary "3-level" cross-sections, such are shown in Fig. 2—*i. e.*, sections defined by a center height and two side heights of slope stakes, with a known width of wad bed and side slope, which in Fig. 3 is 18 ft. and 1½ to 1.

To compute these sections numerically, by well-understood formulas which we will not stop to specify we may use either one of the two following methods:

$$1.\begin{cases}\dfrac{8.4 \times 45.0 + (11.8 + 6.2) \times 9}{2} = 270.00 \\ \dfrac{(9.8 \times 55.5) + (8.8 + 16.2) \times 9}{2} = 384.45\end{cases}$$

$$2.\begin{cases}\dfrac{(8.4 + 6.0) \times 45.0}{2} - 54 = 270.00 \\ \dfrac{(9.8 + 6.0)}{2} \times 55.5 - 54 = 384.45\end{cases}$$

In either case we have for the end-area volume included between these sections

$$\frac{270.00 + 384.45}{2} = 327.225 \times \frac{100}{27} = 1{,}211.94 \text{ cu. yds.}$$

It is evident that the same result would be obtained if we should multiply each area as determined by 100, and divide it by 2 and by 27, and then simply add together the quantities as thus determined, *i. e.*:

$$\frac{270.00 \times 100}{2 \times 27} = 270.00 \times \frac{100}{54} = 500.00$$
$$\frac{384.45 \times 100}{2 \times 27} = 384.45 \times \frac{100}{54} = 711.94$$
$$\text{Total end area volume, as before } 1{,}211.94$$

This is precisely what the "Diagram of Cross-Sections" does. At a single inspection it gives for any possible form of 3-level section up to 35 ft. center height its area $\times \frac{100}{54}$, so that the two readings for any two successive stations 100 ft. apart have only to be added together to give the end area volume.

These readings are taken off by the following rule, which we quote direct from the volume without attempt at further explanation, adding only the practical detail that to use the diagram with maximum advantage two should work together, one reading off the successive center height and widths on top, and another simply reading off from the diagram without having any other use for his eyes. It will then be found that he can read off quantities with the greatest ease and certainty faster than his assistant can call off and set down results.

"21. RULE FOR USE OF DIAGRAM FOR "THREE-LEVEL" CROSS SECTIONS.—First add together the distances out of the two slope-stakes, to obtain the value of D (the horizontal width of section). Then *follow up the* VERTICAL *line representing the given value of D to its intersection, with the* INCLINED *line representing the given centre-height or value of c. Hold the point of intersection, and read off the solidity for a half-station from the horizontal lines.*]

The sum of the quantities for any two sections is the end area solidity between them for a full station. For fractional or *plus* stations, multiply that sum by the proper decimal part of 100 ft.

EXAMPLE.—To compute the solid shown in Fig. 3. For the first section, take on Fig. 2, which is an extract from the complete diagram (14x17 ins. extending to all possible sections up to 35 ft. center height), the vertical line marked 45—the value of D for the first section—and follow it up to the inclined line representing the given center height, 8.4. A heavy line marked 8 is first met with, the next line above is 8.2, and the *next* line is 8.4. Place the needle-point on the intersection of these two lines, and read off the solidity from the horizontal lines.

In this case the point of intersection lies exactly on the line 500, which is the solidity required. Had the center height been 8.6, the solidity would have been 508; had the center height been 8, the solidity would have been 517; and had it been 9.0, the solidity would have been 525.

To read off the solidity of the second section, determine first the vertical line 55.5. This is midway between those marked 55 and 56, and midway between the fine lines for $D = 55.4$ and 55.6. Follow up this imaginary line to the inclined line $c = 9.8$ and, placing the needle-point on the point of intersection, the solidity is seen to be 712; the fine horizontal line for $s = 710$ being immediately below it. The total volume of the solid is then $500 + 712 = 1{,}212$ cu. yds.

21. SECTIONS CAN BE REDUCED TO AN EQUIVALENT LEVEL CENTER HEIGHT by means of the curve of level section, as follows: After having determined the point of intersection for the values of D and c in any given case, and the horizontal line on which it lies, follow along that horizontal line till it intersects the curve of level section. The inclined line of c, interpolated if necessary, which passes through this point of intersection, gives the center height required.

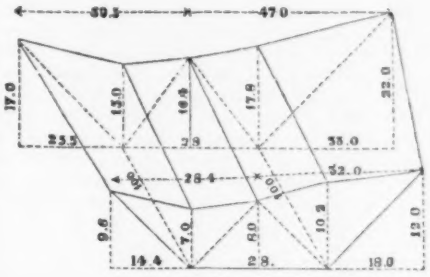


Fig. 4.

The principle of this is obvious. The two sections must necessarily have same area, since the points of intersection found for them are on the same horizontal line.

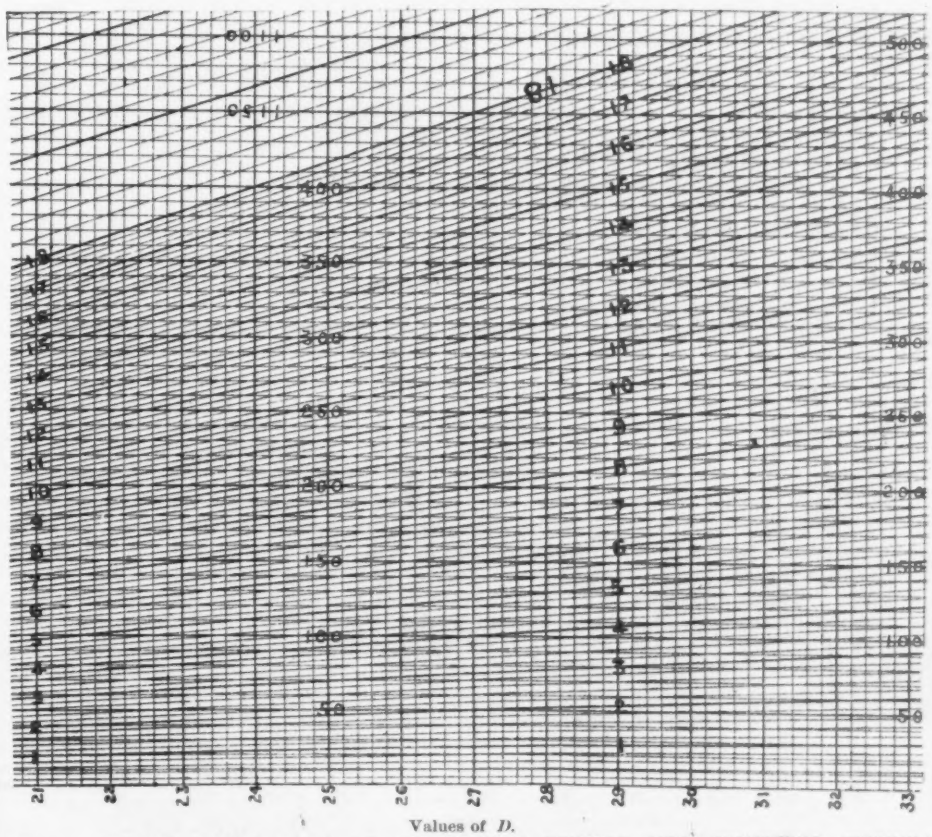
EXAMPLE.—Take the first section of Fig. 3. After determining on Fig. 2 that the point of intersection, as obtained in paragraph 21, lies on the line 500, follow along that line till it cuts the curve of level section. The inclined line passing through the point of intersection is read off as 8.7, which is the equivalent level center height. In the second section the equivalent level center height is read off in the same manner as 11.1.

The following are a series of sections written down at random, all of them coming within the range of the fractional diagram shown in Fig. 2, by which the use of the diagram may be further tested. It will be seen that in any 3-level section the only quantities which really affect the area are (1) the center height and (2) the total width on top from slope-stake to slope-stake. We give the readings in the third column exactly as read off from Fig. 2 at the first inspection, before the last column had been computed:

D. Width on top.	c. Center height.	Reading from diagram.	Exact area $\times \frac{100}{54}$.
45.0	6.0	400	400.00
44.0	7.6	454	454.07
48.0	8.8	544	544.07
46.8	9.4	567	567.52
47.5	10.2	612	612.50
51.3	11.3	722	721.75
Total		3,299	3,299.91

These totals are the end-area solidity of a cut 700 ft. long having end sections of 0.0, and the above sections at intervals of 100 ft. As it chances, the volume as read from the diagram is nearly 1 cu. yd. (0.91) short of the true end-area volume, owing to the error of observed time; but as this error is not cumulative in a long series of sections, even this percentage of error vanishes.

In well-conducted work in rough country, however, there are frequent irregular 3-level sections, *i. e.*, those in which intermediate sections are taken so that the top surface is bounded by three or more (assumed) straight lines instead of by two only, as in Fig. 3. Moreover, in well-conducted double-track work the sections are regularly taken with 5 levels, as in Fig. 4, and finally there are wholly irregular sections, as in Fig. 1. For all such sections the necessary method for computing area is by subdivision of the area into pairs of triangles having a common base, as shown in Fig. 4, and as may be readily indicated on Fig. 1 by drawing diagonals.



Values of D.

FIG. 5. EXTRACT FROM DIAGRAM OF "TRIANGULAR PRISMS" (FOR COMPUTING IRREGULAR EARTHWORK) FROM WELLINGTON'S "COMPUTATION OF RAILWAY EARTHWORK."

For all such areas the "Diagram of Triangular Prisms" is used, an extract from which is given in Fig 5, the full diagram being 14 × 17 ins. in size, and extending to all combinations of triangular dimensions up to 18.0 × 88.0 ft., which by halving either or both dimensions means a range up to 36.0 × 176.0 ft., or practically all which can occur in practice in every form and kind of irregular earthwork. The use of the diagram may be illustrated by computing the solid shown in Fig 4. Entering the diagram (Fig. 5) with—

$D = 28.0$, $c = 16.4$, we obtain.....	425
$D = 39.5$, $c = 15.0$, " "	549*
$D = 47.0$, $c = 17.8$, " "	775*
	1,7
For the second section, entering with—	
$D = 28.0$, $c = 8.0$, we obtain.	207
$D = 28.4$, $c = 6.0$, " "	184
$D = 32.0$, $c = 10.2$, " "	302
	69
Total end-area solidity.....	2,16

*These two readings are not within the range of Fig and consequently must be taken on trust.

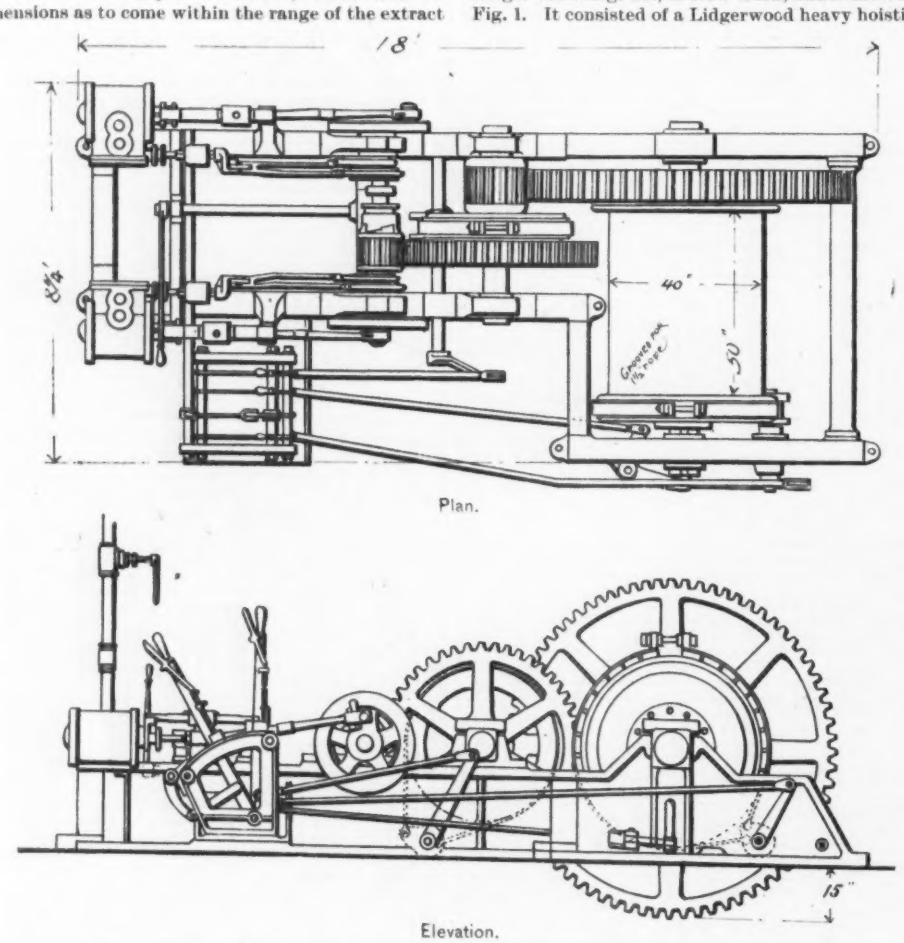
The area ($\times \frac{100}{54}$) of the section shown in Fig. 1 may be read off with equal ease from the full diagram, from which Fig. 5 is taken; the necessary notes for entering the diagram, and the readings as actually taken off, being as follows:

Cut.		Readings.	Exact area. $\times \frac{100}{54}$	*Fill.*		Readings.	Exact area. $\times \frac{100}{54}$
$D=$	$c=$						
4.0	6.8	25	25.18				
5.2	8.0	39	38.52				
9.0	11.8	98	98.33	$D=$	$c=$		
6.9	11.0	61	61.11	19.1	8.0	141	141.48
6.0	4.0	22	22.22	10.7	9.8	97	97.09
Gross total....		245	245.36	Gross total....		238	238.57
−9.0	6.0	50	50.00	−14.7	9.8	133	133.29
Net total.....		195	195.36	Net total.....		105	105.18

If any one will make up an imaginary set of notes like this for two adjacent sections, but of such dimensions as to come within the range of the extract given in Fig. 5 (*i. e.*, with $D = 20.8$ to 33.1 only, and $c = 0.1$ to 18.0), and then compute the volume first numerically and then by reading off from the diagram, he will at once see the great saving of labor in computing from the diagram. The exact solidity by the prismoidal formula is obtained with still greater proportional advantage from diagrams by means of a "prismoidal connection" to be applied to the end area solidities, but into that question we will not now enter.

A New Unloading Plant for Gravel Trains.

We illustrate this week a new method of unloading gravel or ballast trains which has been tried with success this winter on the Delaware & Hudson Canal Co.'s railway. Messrs. Drake & Stratton, of New York, have a contract for grading for 17 miles of second track, near Whitehall, N. Y., through a country where the material is of such a character that in cold weather it freezes badly during the haul on cars from the pit to the place where it is to be unloaded. It was found that a mogul engine of the heaviest type could not drag the side unloader or plow through a train of this frozen material, and when two locomotives were used the brakes would not hold the train stationary. To have abandoned the work until the spring would have caused considerable loss and inconvenience to the contractors and the company, and the contractors therefore decided to try the plan of fitting to the first car of the train a stationary winding or hauling engine for dragging the plow. The plant was furnished by the Lidgerwood Mfg. Co., of New York, and is shown in Fig. 1. It consisted of a Lidgerwood heavy hoisting engine with one drum, guaranteed to lift 25 tons on a single line at a speed of 100 ft. per minute. This engine was mounted on a flat car, 34 ft. long, of 60,000 lbs. capacity, over which a temporary roof was erected, and was supplied with steam from the locomotive through the flexible piping shown in the general view of the construction train, Fig. 2. The plan proved very successful, and resulted in a considerable saving of time as compared with the ordinary plan of attaching the plow to the locomotive by a cable and hauling it along the cars by running the engine ahead. Mr. A. J. SWIFT, Chief Engineer of the road, in a letter to the Lidgerwood Mfg. Co., dated Jan. 24, 1891, stated as follows:



Plan.

Elevation.

FIG 1. HAULING ENGINE FOR PLOW USED FOR UNLOADING GRAVEL TRAIN.

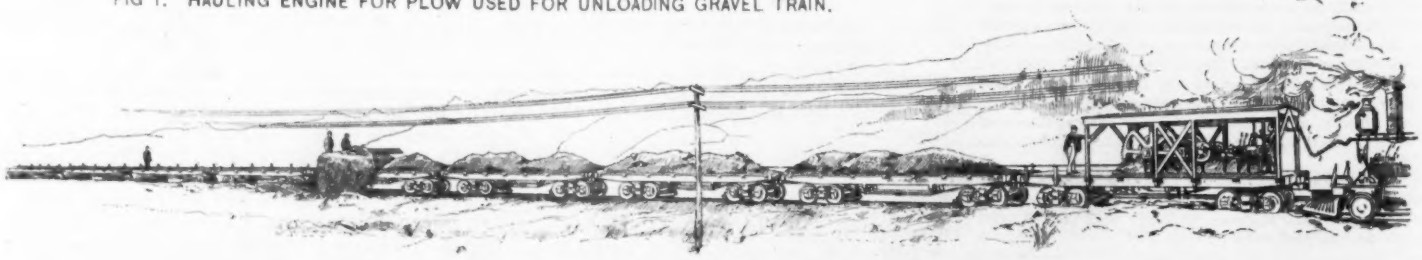


FIG. 2. NEW METHOD OF UNLOADING GRAVEL TRAINS.

From the very first trial the plan proved successful, and the work is now progressing at a satisfactory rate, the unloader breaking up and depositing the frozen material in a way that is surprising. It seems to me so desirable and satisfactory a plan of operation that I feel sure it would recommend itself to any contractor or engineer interested in handling bad or frozen material. It is particularly valuable to the railway company interested in such work, because the action is certain and quick, and enables a construction train to finish its work on the main track, and return to the gravel pit in a fraction of the time occupied by abortive attempts to do the same work by locomotive traction.

The engine does the work well and is very satisfactory and economical. It has been used to unload trains of 16 flat cars. The contractors have recently purchased another hoisting engine of the same kind, and will place it on a car with a boiler, so as to be independent of the locomotive.

Specifications for Cast-Iron Coated Water Pipe.*

At the meeting of the American Water-Works Association this week a paper on the above subject was read by Mr. T. W. YARDLEY, who had read the same paper before the Institute of Mining Engineers at the meeting at Washington, D. C., in February, 1890, and at the convention of the Association in April, 1890. The committee named below was appointed to submit specifications at the next meeting of the Association, and has accordingly submitted those given in the paper, with other matter relative to the subject. The results of the tests made are especially interesting.

It has been the desire and aim of your committee to deal justly with both the manufacturers and the purchasers of pipe, asking nothing of the former that cannot be performed, nor requiring of the inspector any duty to which he cannot give his personal attention. We have carefully considered the method of pipe-making, as well as the present system of inspection at the foundries, and in these particulars we recommend some changes, that, if adopted, will tend to secure a better quality of pipe, without entailing additional cost on the maker. The long established practice of the engineers of the United States Army, as well as hydraulic engineers of eminence, of testing pipe-iron for tensile strength, we think can be improved by the adoption of a transverse test as a more reliable method of securing the best quality of iron for pipe, as well as a nearer representation of the strain the iron must endure when under hydrostatic pressure. Pressure exerted anywhere upon a mass of water is transmitted undiminished in all directions, and acts with the same force upon all equal surfaces, and in a direction at right angles to those surfaces.

Cast-iron pipe which appears to the eye to be sound, and of the proper form, may have one or more of the following imperfections, viz.: First.—A poor quality of iron. Second.—Shrinkage in the metal, due either to improper molding, varying thickness of the shell, or to the too rapid cooling of the melted iron. Third.—Want of uniformity in the thickness of the shell, which is usually due to a want of care, or skill in molding.

The first trouble, poor iron, may be guarded against by the frequent taking of sample bars to be tested in the manner hereinafter specified. An inferior quality of iron

*Slightly abbreviated from the report on this subject presented at the eleventh annual convention of the American Water-Works Association, Philadelphia, April 14 to 17, 1891, by Mr. T. W. YARDLEY, of Chicago, Chairman of Committee, of which Mr. S. BENT RUSSELL, of St. Louis, and Mr. A. J. GUILFORD, of Chicago, were the other members.

will result in losses from breakage in transportation and handling, difficulty in cutting the pipe without getting split ends, or irregular breaks, and in failure of the pipe when subjected to a heavy water ram, which tests the toughness of the iron, as well as its tensile strength. When a pipe is under hydrostatic pressure at the works, there can be no water ram, and the water is practically free of air. Neither of these conditions exist in practice; the water is not free of air in service, and the sudden closing of a valve will certainly produce a water ram, and these blows will be repeated with greater frequency as water motors come into more general use. There is no way provided to anticipate the call for an excess of water, and the sudden closing of a valve will most certainly endanger the pipe. As this cannot be guarded against, all we can do is to secure the best quality, and thereby reduce the chances of burst pipe to the minimum. The second trouble, shrinkage strains, deserves to bear by far the burden of the largest share of bad names which cast-iron has received as a structural material. This fault is inexcusable, and it will only be remedied when the consumer, by rigid inspection, insists that the metal receive the proper treatment from the time it enters the flask until it is coated and tested. A custom has grown among pipe makers during the past few years of removing pipe from the pit before it is sufficiently cool. This is a very bad foundry practice, and should not be permitted. Pipe should not be stripped and taken from the pit while showing color of heat, for the reason that, when hot pipe is exposed to a sudden chill from cold air, the shrinkage of the outer surface will induce internal strains, and pipe in such condition will be liable to give way in the trenches. Too great stress cannot be laid on this matter of cooling down. It is a waste of money to buy good iron, if it is not treated with the greatest care while cooling down from the melted state. The hydraulic test under a high pressure, supplemented by the hammer test, is a detective on shrinking strains. But it is a matter of record that water-pipe has been made from a superior quality of tested iron, tested by the hammer under heavy hydrostatic pressure, laid in the trenches and again tested, only to burst several months later under pressure much less than that of either test, with no evidence of any water-ram, and no flaws to be found in the break. That pipe must have been unfairly treated in the foundry.

The third trouble is usually caused by the core being out of center. This should not be undervalued. It is not only that the pipe is too thin on one side. The worst feature is that the thin side is almost sure to cool the quicker, thus again producing the shrinking strains which are so destructive to the strength of iron. Our present requirement of hydraulic pressure is severe enough to detect this irregularity of thickness, but the inspector should not depend on it with too much confidence. When in doubt, every pipe should be calipered. The most reliable test we have is the test of the finished pipe by hydraulic pressure, while it is being thoroughly sounded by the hammer. The usual practice is to test every size pipe to 300 lbs. pressure per sq. in. This, however, may be shown to be unfair to the larger sizes of pipe. When we subject 6-in pipe, with shell ½-in. thick, to an internal hydrostatic pressure of 300 lbs. per sq. in., we have an average tensile strain on the metal of 1,800 lbs. per sq. in. If we subject a 36-in. pipe, with shell 1¼ ins. thick, to the same internal pressure, we have an average tensile stress on the metal of 4,320 lbs. per sq. in. Accepting the bursting pressure of pipe at 16,500 lbs. per sq. in., as given by the best authority, Fairbairn, the 6-in. pipe would have a safety factor of nine, and the 36-in. pipe a safety factor of about four.

As a matter of comparison, we give the diameter, thickness and varying strains per square inch of metal under 300 and 250 lbs. hydrostatic pressure, as follows:

Diameter, ins.	Thickness, ins.	Strain in lbs. at 300 lbs. pressure.	Strain in lbs. at 250 lbs. pressure.
6	.505	1,782	1,485
8	.562	2,135	1,780
10	.619	2,423	2,020
12	.677	2,659	2,215
16	.794	3,024	2,519
20	.905	3,312	2,762
24	1.020	3,528	2,941
30	1.192	3,774	3,146
36	1.363	3,960	3,302
48	1.707	4,218	3,515

There is, however, a mechanical reason why the pressure on the larger pipe might be reduced to 250 lbs., namely, the fact of the difficulty of getting a water-tight joint on the large pipe when under 300 lbs. pressure. Your committee, therefore, recommends that the test pressure at the foundry be made to conform to Sec. 17 of these specifications.

To determine the value of wrought iron, we measure its tensile strength and its elongation. If the iron is hard and granular, it will show high tensile strength, but will be low in elongation; the best element of wrought iron. The value of cast iron may be determined in the same way, but its elongation is too small to be readily measured in a tensile test. The same result may be reached by measuring the deflection of a bar before breaking under a transverse test, which can be measured with accuracy. The thickness of test bars should correspond with the thickness of the shell of the pipe it represents, and like the pipe should be cast in molds, or dry sand, vertically so that the test bar would in every particular represent the iron in the pipe. For several reasons this would be impracticable, and we, therefore, recommend the adoption of a bar for transverse test 26 ins. long and 2 ins. wide and 1 in. thick, to be loaded in the center, between supports 24 ins. apart. This bar is inexpensive to the manufacturers, and can be made sufficiently accurate in dimensions to be ready for the testing machine before the pipe of which it is the representative, is stripped and ready for the hydrostatic and hammer test. The inspector has full knowledge of the character of the iron, and whether the pipe be accepted or rejected the inspection will have been made with a greater degree of intelligence than is possible under the present system of tensile tests, the results of which generally reach the inspector a day or two after the pipe has passed from his hands.

TABLE OF TESTED BARS, 24 × 2 × 1 INS.

Width, ins.	Thickness, ins.	Deflection, ins.	Transverse, load, lbs.	Tensile strength, lbs.
2.	1.	.406	1,850	21,150
2.	1.031	.437	2,050	20,100
2.	1.	.312	1,850	20,200
2.	1.	*.281	*1,440	21,010
2.	1.	.375	1,850	19,020
2.	1.031	.406	2,230	18,200
2.	.750	*.250	*1,310	21,000
2.031	1.	.437	2,200	19,500
2.	1.	.437	2,100	18,850
2.031	1.	.375	1,840	19,010
2.	1.031	.437	2,230	19,750
2.	1.	.375	1,800	21,500
2.	1.031	.419	2,240	19,100
2.	.947	.312	1,620	20,000
2.	1.	.312	1,850	21,755
2.	1.	.312	1,760	19,000
2.031	.937	.437	1,800	21,400
2.	1.	.415	2,100	20,100
2.031	.987	.408	1,800	19,200
2.	1.	.437	1,800	19,400
2.	1.	.437	2,020	23,000
2.	1.031	.375	2,260	21,100
2.031	.937	.400	1,880	20,040
2.	1.	.437	2,200	19,800
2.	1.	.415	2,040	21,000
2.	1.031	*.245	*1,520	19,450
2.062	1.	.265	1,795	18,950
2.	1.046	.265	1,800	22,900
2.062	1.031	.277	2,010	20,250
2.	1.078	.277	1,990	20,000
2.031	1.031	.285	1,955	21,100
2.031	1.	.280	1 800	18,910
2.	1.	.275	1,800	21,650

*Defective.

Average width of above	2.01	ins.
" thickness	.998	"
" deflection	.358	"
" transverse strength	1.903	lbs.
" tensile strength	20,224	"

Selecting the same number of bars, which are exactly 2 × 1 ins., and taking an average of their deflection and transverse and tensile strength, we have the following:

Deflection	.373 ins.
Transverse strength	1.890 lbs.
Tensile strength	20,531 "

TABLE OF TESTED BARS, 18 × 3 × ½ ins.

Width, ins.	Thickness, ins.	Deflection, ins.	Transverse load, lbs.
3.	.51	.305	1,090
3.	.55	.346	1,275
2.96	.48	.350	900
3.26	.56	.300	1,770
3.	.53	.280	1,290
3.24	.52	.300	1,480
3.	.53	.230	2,000
3.	.55	.250	1,250
3.	.55	.270	1,200
3.02	.52	.350	1,070
3.02	.52	.360	1,075
3.	.53	.310	1,200
3.	.49	.300	1,000
2.85	.50	.320	980
2.95	.50	.430	1,100
3.05	.50	.400	1,230
3.	.50	.300	1,200
3.	.50	.395	1,225
3.05	.50	.457	1,325
3.02	.50	.408	1,250
3.04	.49	.400	1,238
3.	.52	.412	1,300
3.	.51	.430	1,400
3.	.55	.388	1,400
3.	.52	.410	1,300
3.07	.52	.370	1,400
3.05	.54	.449	1,550
3.04	.54	.390	1,500
3.02	.46	.408	1,100
3.	.50	.027	1,200
3.05	.50	.305	1,300
3.06	.50	.471	1,450
3.05	.50	.457	1,400
3.	.50	.342	1,200
3.03	.49	.430	1,250
3.05	.49	.403	1,300
3.05	.50	.417	1,200

Average width of above	3.02	ins.
" thickness	.513	"
" deflection	.370	"
" transverse strength	1,276	lbs.

Selecting the same number of bars which are exactly 3 × 1½ ins., and taking an average of their deflection and transverse strength, we have the following:

Deflection	.317 ins.
Transverse strength	1,200 lbs.

For your information we append the result of 140 test bars. Of these 33 were the average castings. Others that were selected were of the exact size, 2 × 1 ins. There were 33 duplicate bars cast from the same iron. These were tested for tensile strength. In addition we give the result of 37 test bars, 18 × 3 × ¼ ins. The iron from which all these bars were cast was made by and represents the average quality of irons used by the best makers of pipe. The size bar we recommend is practically the average thickness of the shell of the large diameters of pipe, and the sizes that require the greatest care in making, as well as the most rigid inspection.

SPECIFICATIONS FOR CAST-IRON COATED WATER PIPE.

1. The pipe shall be the usual kind, known as "hub and spigot"; each pipe shall be 12 ft. in length from the bottom of the hub to the end of the spigot. The form and dimensions of hub and spigot ends shall be as marked on and shown by drawings, to be furnished or approved by the purchaser.

2. The metal shall be of the best quality for the purpose, made from what is commercially known as "neutral" pig iron, which shall have been made from iron ores without the admixture of cinder, and, when cast into pipe, the metal shall be tough, and of such density and texture as will permit of its being easily cut and drilled by hand.

3. Each pipe shall have cast on its exterior surface in raised roman letters, 1½ ins. long, and shall be further marked in like manner with letters and figures to designate the maker of the pipe and the year; also serial numbers shall be cast on each pipe, commencing with a number to be designated by the purchaser.

4. The pipe shall be cast in dry sand molds, or flasks, placed vertically, and shall be of the several diameters named in the contract.

5. The shell shall be smooth and sound, without cold-shuts, lumps, swells, scales, blisters, sand-holes or other imperfections; truly cylindrical, of full diameters, and with interior and exterior surfaces concentric.

6. The shell shall be of uniform thickness throughout its entire length. Should the inspector find in any one place a variation in thickness of more than 10%, either greater or less, from that specified in the contract, such pipe shall be rejected.

7. Should the inspector have cause to believe that pig iron, with "an admixture of cinder," was being used, all pipe from such iron shall be rejected until satisfactory evidence to the contrary shall have been furnished.

8. Test bars shall be cast as often as the inspector may deem necessary for his information, and, if the tests do not come up to the requiremets of Sec. 10, all pipe made from such iron shall be rejected.

9. Test bars shall be taken as required by Sec. 8, and shall be 26 ins. long, 2 ins. wide and 1 in. thick.

10. Those bars shall be tested for transverse strength when loaded in the center, 24 ins. between supports (narrow sides vertical), and shall carry a center breaking load of not less than 1,900 lbs., and show a deflection of not less than .25 in. before breaking.

11. These bars shall be cast as near as possible to the specified dimensions, without finishing up, but corrections shall be made for variation of width and thickness, and the corrected result must conform to the above requirements.

12. Pipe shall not be stripped and taken from the pit while showing color of heat.

13. Pipe shall be thoroughly cleaned, both inside and outside, without the use of acid or other liquid.

14. When the pipe is so cleaned it shall be heated to 360° Fahr., and immersed in a bath of coal-pitch varnish of an equal temperature.

15. When the pipe is removed from the bath, the coating shall *fume freely*, and set perfectly hard within one hour from the time of its removal.

16. No pipe shall be tested by hydrostatic pressure until the varnish has become hard.

17. When coated, the pipe shall be subjected to a test by hydrostatic pressure of not less than 300 lbs. per sq. in., for all pipe 12 ins. in diameter and under, and 250 lbs. per sq. in. for all sizes above 12 ins. While under such pressure, the pipe shall be subjected to an additional test by a series of blows at various points throughout its entire length, with a 3 lb. hammer, attached to a handle 16 ins. long. If any failure is shown in the pipe during this test, it shall be rejected.

18. The maker shall furnish to the inspector two wrought-iron rings, male and female templates, the one showing the outside diameter of the spigot end, and the other the inside diameter of the hub end of each size pipe; and the said pipe, with the proper allowance for diameters, shall conform to the respective templates.

19. The weight of each pipe must correspond as nearly as possible to the standard named. Any pipe which may fall short over 3% of the standard weight which shall be rejected, and no pipe shall be allowed or paid for, that shall exceed 3% standard weight. These requirements shall be determined by the weight of each pipe separately.

20. All appliances necessary for the inspector to carry out the requirements of these specifications shall be furnished by the maker, free of charge to the purchaser

The Columbia River Jetty.

An interesting piece of work has been nearly completed at the mouth of the Columbia River, Oregon, under direction of Major THOS. H. HANDBURY, Col. G. H. MENDELL, and Lieut. EDWARD BURR, U. S. Engrs. The work consists in the building of a low stone jetty, starting from Ft. Stevens, on the mainland at the south side of the mouth of the Columbia River, and extending out into the ocean about 4½ miles. The water at mean low tide is from 10 to 20 ft. deep along the line of the jetty.

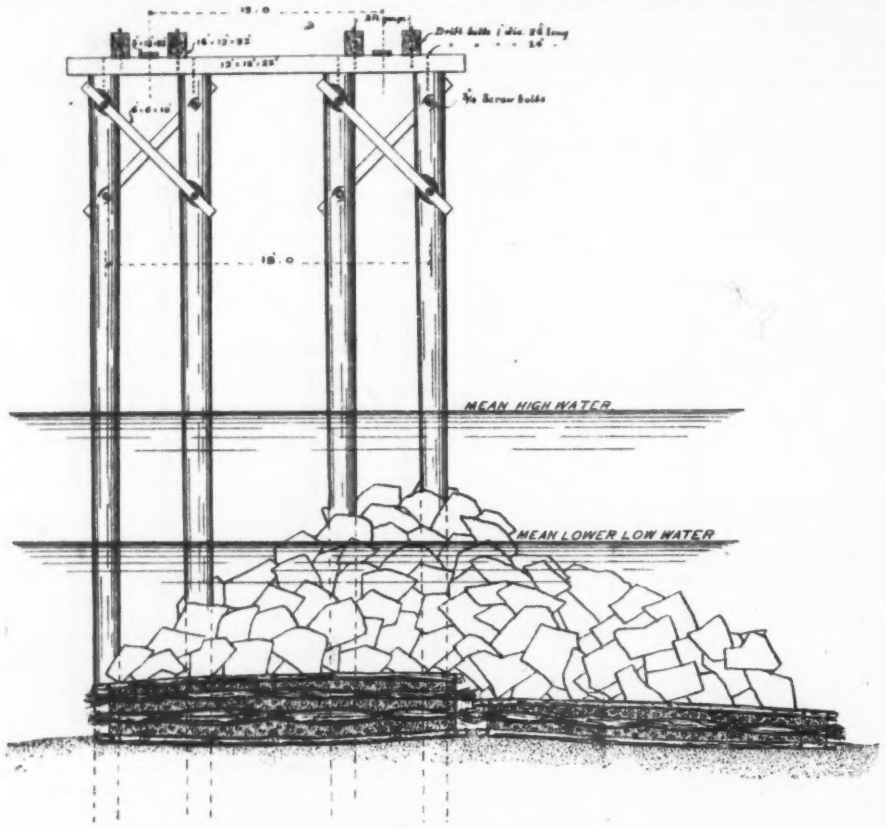


FIG. 1 CROSS-SECTION OF JETTY.

The method of construction adopted is very simple. A double track railway supported on piles is built along the jetty, and is kept just in advance of it. Fig. 1 shows a cross-section of the completed jetty. The stone is dumped only to the level of mean low water. The piles, which are driven in advance of the work, are 55 to 65 ft. in length, and cost 8 cts. per ft. delivered on the work. After the piles are driven, the timbers and track for the railway are put in place, and a mattress of brush and poles, 2 to 5 ft. thick, and about 40 ft. wide, is built and placed on the bottom, as shown in Fig. 1. On this the rock is dumped from self-dumping cars running on the railway tracks.

The mattress is built in two parts. The inside mat is built by supporting the base poles from hooks resting on the longitudinal timbers, as shown in Fig. 2. The outside mattress is built on shore and carried out to place on the cars. It is dumped from the cars into the water, and both mattresses are sunk to place by loading with small stone.

The stone for the work is brought from the quarry to the wharf at Ft. Stevens by government barges, and is loaded into self-righting dump cars holding 5 to 8 tons each. Two men can dump a train of 20 of these cars in five minutes. Four locomotives and 52 dump cars are used on the work. Some experiments have been made with mixtures of paraffine and crude petroleum to stop the corrosion of the rails, which is very rapid here, as they are constantly exposed to the salt spray. Several proportions of the mixture were tried, but no difference could be noted between the rails coated and those not coated, after they had been in the track a couple of months.

The piles are all driven by a jet pile-driver, which works admirably in the soft sand. One of these machines has been in use since the commencement of the works, but it became rather shaky, so a new one was built and is illustrated in Fig. 4. The machine is described as follows by Mr. G. B. HEGARDT, the engineer in charge:

The whole of the upper portion is mounted upon a car composed of trussed wooden beams, connected and bolted together, forming a strong rectangular framework 17 ft. long and 19 ft wide, thus extending over and running on both tracks. This car-frame is supported at each of the four corners by a double truck of 8 wheels, making 32 wheels in all.

The axles run in brass bearings in pedestals, which are bolted to square frames of 7-in. channel-bars; and resting across the top of these frames are two 12 in. bars, from which are suspended the centre pins of the trucks. The two centre pins of a pair of trucks extend down through and support a box-girder of plates and I-beams about 6 ft. long, and upon this girder rests the wood framework of the car. Upon the car is a roller path 16 ft. in diameter, of 30-lb. rail: a similar one, but inverted, is secured to the upper or revolving portion of the driver. This turn-table runs upon 48 steel rollers.

The upper portion of the driver consists of a braced platform, supported at the ends by hog-stays, and carrying the gins at one end and the boiler, tanks, fuel, etc., at the other. The pump is carried on a frame which is suspended over the side of the track; the steam for working it is passed through pipes, which are connected by flexible hose with couplings for detaching when the driver revolves. Couplings are also provided on the water-discharge hose for the same purpose.

The discharge-hose (4½ ins.) is connected to a **V**-pipe, which has two 2½-in. branches, each having a gate-valve; the two pipes lead upward and connect with two lengths of hose passing over large pulleys running in a frame, which slides in vertical guides; the other ends have couplings to connect with the jet-pipes on the piles. The jet-pipes are 1¼ ins in diameter, and two of them are secured to each pile by means of staples.

The method of working is as follows: The driver is revolved by means of a pinion and toothed segment until the gins are opposite the tender car, which contains material for construction. A line is attached to the large end of the pile, and, passing over sheaves at the gin top, leads to a drum on the engine. Another line is attached to the small end of pile and leads through a block on the gins, then down to a guide pulley on the platform, and thence to a capstan head on one of the engine shafts. The pile is lifted horizontally off the tender car, the driver is then revolved and secured in the required position, the small end of the pile is lowered, and the line detached, leaving the pile suspended between the leaders.

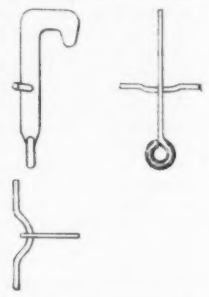


Fig. 3. Mattress Hook.

The hose pipes are then coupled to the jet pipes, which have permanently fastened to each of them a short piece of chain terminating in a ring and dowel. The ends of the chains are brought together and the dowels lightly driven into the pile; a 4-in. line is made fast to the rings, and, leading up, passes through a block on the gins; another smaller line is hooked to the rings, and, passing over guide pulleys, depresses the hose pulley frame and relieves the hose pipes from tension, when the pile sinks to the bottom. The hammer is then lowered and allowed to rest on the pile, the pump is started, and the pile begins to sink into the sand.

When the head of the pile has come within five or six inches of its required level the pump is stopped, the hammer raised, and the 4-in. line hauled up, pulling out the dowels and drawing up the two jet pipes through the staples clear of the pile. A few light blows with the hammer bring the head of pile to grade. When a row of four piles has been driven a cap is bolted across; the stringers and rails are then extended, and the driver moved forward for the next bent.

The end of the jetty is now a little over 3¼ miles from the shore; and a marked improvement in the depth of the channel has already been secured. Large deposits of sand have taken place on each side of the jetty, which it is expected will eventually protect the rather frail barrier from destruction by storms. Before the commencement of the work the channels across the bar were very capricious and variable in depth. The depths were from 18 to 21 ft., and the

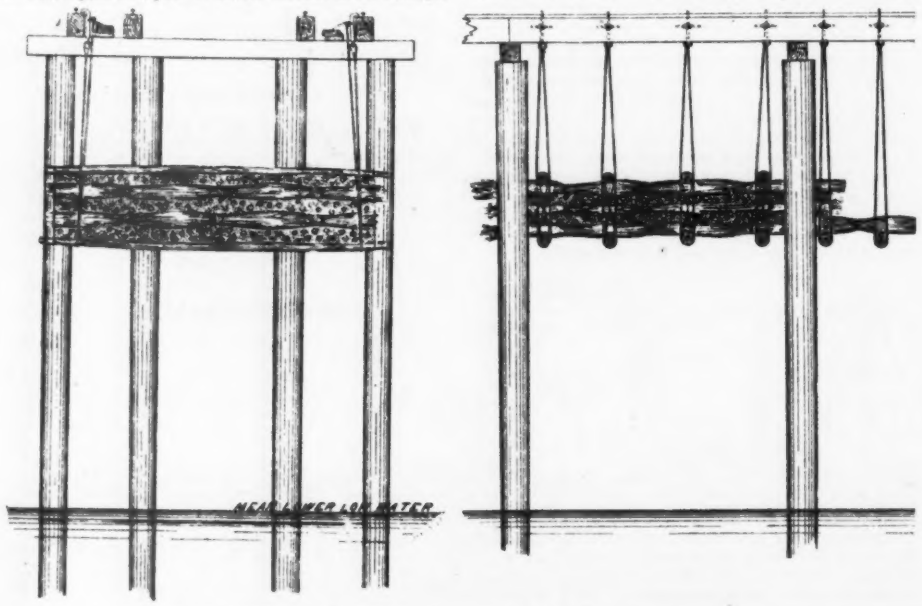


FIG. 2. INSIDE MATTRESS IN PROCESS OF CONSTRUCTION.

channels varied from one to three in number and in position through nearly 180°. There is now a straight out and in channel with 25 ft. of water at low tide. The distance between the 30 ft. curves on each side the bar was 1½ miles in 1885. This distance has now been reduced to less than ½ mile.

The total cost of the portion of the work completed June 30, 1890, was $841,000, or about $50 per lineal foot of jetty. The amount necessary for the completion of the work as originally projected is $525,000, making the total cost of the work about $1,366,000. The estimate of cost submitted by the Board of Engineers, whose general project for the work was adopted in 1884, was $3,710,000. Thus if no accident or delay occurs to increase the cost over what is now apparent, the work will be done for between one half and one-third of the original estimate.

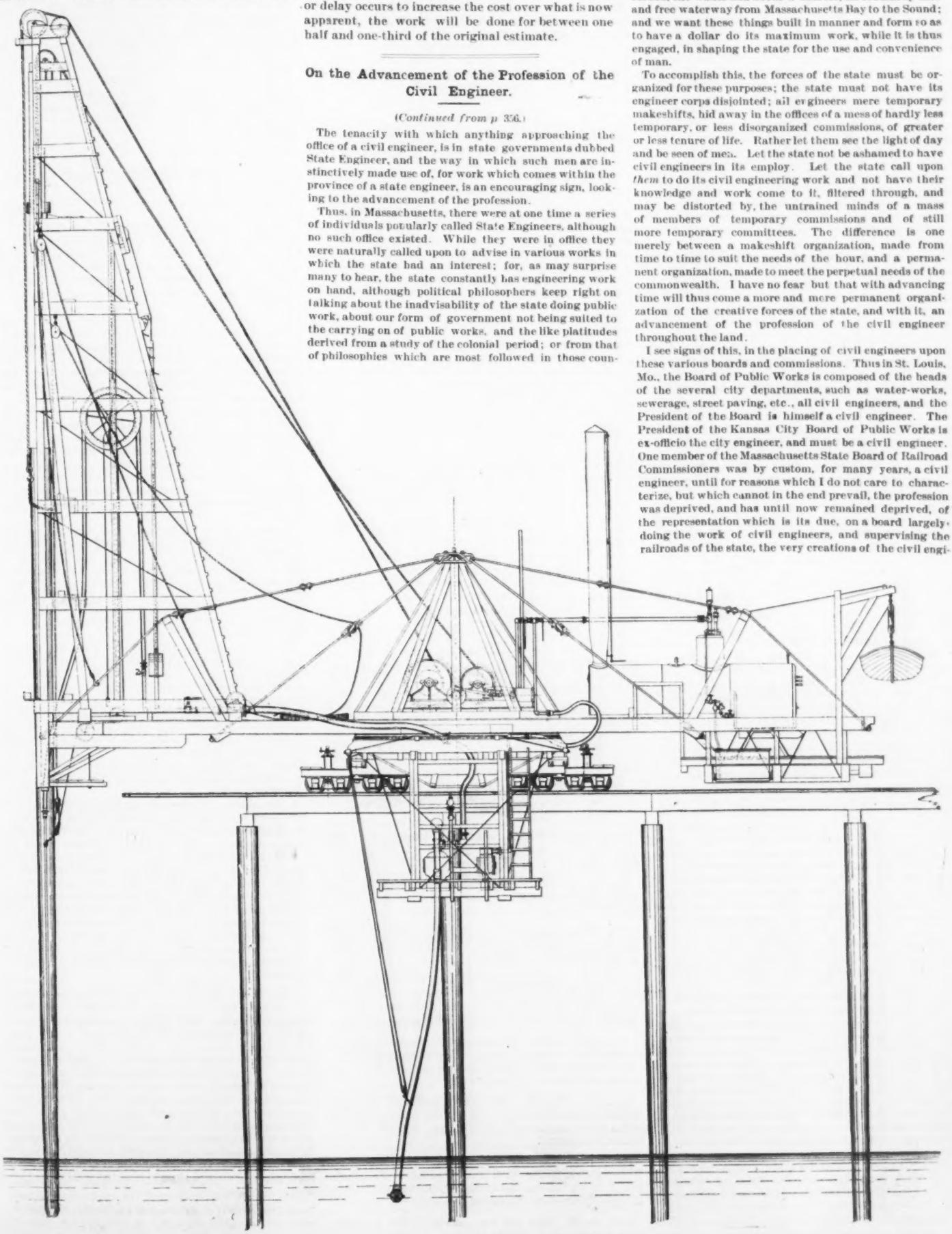


FIG. 4. REVOLVING PILE DRIVER.

On the Advancement of the Profession of the Civil Engineer.

(*Continued from p. 356.*)

The tenacity with which anything approaching the office of a civil engineer, is in state governments dubbed State Engineer, and the way in which such men are instinctively made use of, for work which comes within the province of a state engineer, is an encouraging sign, looking to the advancement of the profession.

Thus, in Massachusetts, there were at one time a series of individuals potularly called State Engineers, although no such office existed. While they were in office they were naturally called upon to advise in various works in which the state had an interest; for, as may surprise many to hear, the state constantly has engineering work on hand, although political philosophers keep right on talking about the inadvisability of the state doing public work, about our form of government not being suited to the carrying on of public works, and the like platitudes derived from a study of the colonial period; or from that of philosophies which are most followed in those countries which do *not* excel in their public works, and are *not* followed in those countries that do.

The matter appears to be a very simple one: We want good roads; we want various other state engineering work done, such as systems of main drainage, the regulation and control—in some remote, more perfect age—possibly, the operation of railways. As far as Massachusetts is concerned, she wants and needs a shorter, an ordinarily safe and free waterway from Massachusetts Bay to the Sound; and we want these things built in manner and form so as to have a dollar do its maximum work, while it is thus engaged, in shaping the state for the use and convenience of man.

To accomplish this, the forces of the state must be organized for these purposes; the state must not have its engineer corps disjointed; all engineers mere temporary makeshifts, hid away in the offices of a mess of hardly less temporary, or less disorganized commissions, of greater or less tenure of life. Rather let them see the light of day and be seen of men. Let the state not be ashamed to have civil engineers in its employ. Let the state call upon *them* to do its civil engineering work and not have their knowledge and work come to it, filtered through, and may be distorted by, the untrained minds of a mass of members of temporary commissions and of still more temporary committees. The difference is one merely between a makeshift organization, made from time to time to suit the needs of the hour, and a permanent organization, made to meet the perpetual needs of the commonwealth. I have no fear but that with advancing time will thus come a more and more permanent organization of the creative forces of the state, and with it, an advancement of the profession of the civil engineer throughout the land.

I see signs of this, in the placing of civil engineers upon these various boards and commissions. Thus in St. Louis, Mo., the Board of Public Works is composed of the heads of the several city departments, such as water-works, sewerage, street paving, etc., all civil engineers, and the President of the Board is himself a civil engineer. The President of the Kansas City Board of Public Works is ex-officio the city engineer, and must be a civil engineer. One member of the Massachusetts State Board of Railroad Commissioners was by custom, for many years, a civil engineer, until for reasons which I do not care to characterize, but which cannot in the end prevail, the profession was deprived, and has until now remained deprived, of the representation which is its due, on a board largely doing the work of civil engineers, and supervising the railroads of the state, the very creations of the civil engi-

neer. For two illustrations of the work of a state engineer being done in a hidden, furtive way, and as though the state were ashamed of it, when it might be to that state's glory, I would point to the States of New York and New Jersey. By reason of its ownership of the Erie Canal, the State of New York must have a corps of engineers engaged upon the repairs of the canal, whose chief is termed the State Engineer, and who, by reason of such appelation, is called upon to do various engineering work for the state. I will anticipate the arguments that will immediately be brought against public works of a state, drawn from the popular conception of waste on the Erie canal; not by a counter recitation of the benefits which this canal has conferred on the State and city of New York, but by the assertion that civil engineers are not put in position to make such waste impossible. If the works of the state were placed in charge of a permanent corps of engineers, such as we have seen are employed in like cases on the continent of Europe, like results would follow from like situations. They would prevent waste. It is idle to talk of doing away with all public works; we have always had them, we have them now, and always will have them. It is better to organize accordingly and permanently; and in such organization the creator of these works will surely, must surely, be given the charge of their proper maintenance and extension.

The other illustration which has occurred to me of state engineering having been done in a thoroughly round about way, and as though it were something to be hidden or apologized for, is illustrated by the beautiful topographical survey of the State of New Jersey. Here is an engineering work of the greatest practical value, done by the chance incident of an old time appropriation, for a geological survey, continued and extended in its scope from year to year. New Jersey has taken the lead in thus picturing its territory so as to show all the elements of a sculptured representation of that surface; a work of great and lasting use in any community. Massachusetts has lately done likewise, and other states will no doubt follow. Shall they wait for a fortuitous conjunction of favorable circumstances to get this work done in some round about, bungling manner, or shall an advancement of the profession of the civil engineer to the point that states have state engineers render the accomplishment of this and other engineering works natural and in due course?

The inspection and control of railway traffic in Great Britain and her colonies, and the improvement of rivers and harbors in the United States, are two parallel cases of an overslaughing of the civil engineer by the military engineer; in each case without good reason, and merely because the government has not been organized to do the work it has in hand to the point of providing itself with a corps of civil engineers. Says a popular author, in his "Departmental Ditties":

By the Laws of the Family Circle, 'tis written in letters of brass,
That only a Colonel from Chatham can manage the Railways of State,
Because of the gold on his breeches, and the subjects wherein he must pass;
Because in all matters, that deal *not* with Railways his knowledge is great.

To make the situation plain to American engineers, let us suppose all State Railroad Commissions abolished, and the Interstate Commerce Commission doing their work on the railroads of the United States. This would be the British "Board of Trade." Then let us suppose the Interstate Commerce Commission calling upon army officers to do the work now done, either by engineer members of the State Railroad Commissions, or by engineer employees of such commissions; and we should then have the situation which has been pictured in the departmental ditty above quoted, and which prevails throughout Great Britain and her colonies. Such use of army officers sounds ridiculous enough, but is perfectly paralleled by what we do in the improvement of the rivers and harbors of the United States. Here, if anywhere, is the work of a civil engineer; it is constantly with us; but instead of providing for its accomplishment by a permanently organized corps of civil engineers, we detail officers of the United States Army temporarily for such work.

We first educate men by means of infantry, cavalry and artillery drill, and by military studies, to be soldiers, and then set them to doing something else, and to learn the art of the civil engineer practically on the work they are to do; all for the sake of deluding ourselves with the idea that the United States Government does not need the services of a corps of civil engineers. Shameful, in the extreme, is the position in which this course places that large body of civil engineers who must of necessity be employed on these United States river and harbor works, and who constitute a pariah caste that can never rise above the rank of low-grade assistants to the privileged army detail for civil work. These works cannot be built without the aid of a very great number of civil engineers, and such are in the constant employ of the government, many times outnumbering their army masters, and in numerous cases their superiors in age, experience or in knowledge; but they are not recognized by the government, and have positively no avenue of merited promotion. As a natural consequence, the country is deprived of the services of its best men in this work; for no civil engineer will stay in such employment that is not forced to do it by stress of adverse circumstances. In the United States, the profession can do nothing that will so much further its own advancement as to educate the people and Congress to the great wrong that is being done it, by taking away from it work, which is for the civil engineer to do, and by giving this work to army officers, temporarily detailed for the purpose, to be done by them, and by the large body of their unrecognized civil assistants.

The appointment of the Interstate Commerce Commission gave the President of the United States an opportunity to recognize the principle of appointing civil engineers to do the work of a civil engineer in a co-ordinate branch of the government. The Commission is large enough—it is composed of five members—to have room in it for men trained in the operation of railroads, civil engineers and other experts, besides a due proportion of lawyers; but the President, himself a lawyer, appointed only lawyers.

Passing to the other extreme, there is no particular reason why railroad men and civil engineers would not have made a much more useful commission, one better fitted to control the railroads of the country for the use and convenience of man, than so many lawyers. Questions of law could have been left to the courts already provided, or the Commission could have engaged counsel as readily, as another could engage the services of a civil engineer; and certain it is that much work left undone, and for which the country is ready and anxious, would, in that event, long ago have been at least begun.

But in our day the country is lawyer mad, and it is no insignificant sign of the times to see a political party arising which would exclude lawyers from *all* participation in the government of the country.

Men will naturally undertake work for which they have been fitted by past training, which they have learned to like. In other of the world's work they as naturally remain passive. They do not see it waiting to be done; they do not hear the demands made that it be done. Thus it naturally came to pass that, with a crying need for a regulation and for a unification of numerous railway safety appliances, which none but a national organization could supply, the Interstate Commerce Commission saw nothing of all this, and did nothing. Spurred to take up these subjects by conventions of the State Railroad Commissions, it nevertheless neglects them, and instead spends the bulk of its time and energies in judicial work, which the courts could do better.

Prominent men in railway life, men who do not usually write for newspapers, have been urged by the pity of the situation to write to the same effect, and many editorials have had this for their theme.

(*To be continued*).

PERSONALS.

Mr. L. W. BURT has been elected City Surveyor of Hartford, Conn.

Mr. E. MARSH, Superintendent of the Birmingham Sheffield & Tennessee River Ry., has resigned.

Mr. E. DICKINSON, General Superintendent of the Baltimore & Ohio R. R., west of the Ohio river, has resigned.

Mr. JOHN M. MITCHELL will resign his position as a member of the Board of Railroad Commissioners of New Hampshire.

Mr. HENRY BACON, Assistant Engineer on the improvement of the Cape Fear River, died at Wilmington, N. C., April 12.

Mr. G. A. LUND, formerly with the Pottsville Iron & Steel Co, has accepted a position with the New Jersey Steel & Iron Co.

Mr. STEPHEN B. TINKER, Superintendent of Motive Power of the Cincinnati, Wabash & Michigan Ry. died at Wabash, Ind., April 11.

Mr. W. J. EDBROOKE, of Chicago, Ill., has been appointed Supervising Architect of the Treasury Department, Washington, D. C., vice Mr. J. H. WINDRIM, resigned.

Mr. SAMUEL REA, M. Am. Soc. C. E., has resigned his positions as Chief Engineer of the Baltimore Belt R R. and Vice-President and Chief Engineer of the Maryland Central Ry., on account of ill health.

Mr. C. C. ELWELL has been appointed Division Engineer of Maintenance of Way on the Philadelphia division of the Baltimore & Ohio R. R., vice Mr. W. A. PRATT, transferred.

Mr. J. E. LARKIN, an engineer on the Philadelphia, Wilmington & Baltimore R. R., died at Havre de Grace, Md., April 11. He was one of the engineers of the Havre de Grace Bridge over the Susquehanna River.

COL. S. H. LOCKETT has accepted the position offered him by the government of the United States of Colombia as Chief Engineer of the water-works of Bogota, which are to be considerably enlarged. The water supply is of very superior quality, coming by gravity from mountain streams supplied by melting snows.

Mr. WM. F. SHUNK and Messrs. BINGERS, PARKER, DEMPSEY, CONNOLLY and Dr. OGDEN, U. S. N., of his party; also Messrs. J. IMBRIE MILLER, W. D. KELLY, Jr., FOSTER, WILSON, MARTINEZ and Dr. RUSH, U. S. N., of his party, sailed by steamer *Newport* for Guayaquil, Ecuador, on April 10. They will there outfit and go to Quito, whence Mr. SHUNK's party will work north, and Mr. MILLER's south. Mr. SHUNK's party will connect somewhere near the isthmus with the government party surveying through Central America. It is expected that at least a year will be required for these preliminary surveys. The stadia will be largely used instead of chaining, and the transit and aneroids will be used for determining elevations.

NEW PUBLICATIONS.

—*The Elements of Dynamic Electricity and Magnetism.* By PHILIP ATKINSON, A. M., Ph. D. New York, D. Van Nostrand Co. Cloth, 12mo; pp. 405; 120 cuts. $2.

Dr. ATKINSON is well known to readers of elementary books on electricity as the author of two favorite works in that science, "Static Electricity" and "Electric Lighting." In the preface to the present volume he states that "this book was written for learners rather than the learned." This is self-evident. The first cut noticed on taking up the book, that of the dynamo of the Compaignie l'Alliance, was an old friend of the time of academical studies, and several others can be found in the original French edition of GANOT's "Physique," dated 1876. Many of the other illustrations are familiar trade cuts, and, while of more or less value as an aid to the text, are by no means attractive, and are sometimes misleading.

One of the classes for whom the work was written "are students who intend to become electrical engineers, to whom a thorough knowledge of elementary, physical, electric principles is important as a preparation for a more extended mathematical course."

Sir WILLIAM THOMSON, who is generally believed to know as much about practical and theoretical electricity as any one, once stated to the Institution of Civil Engineers:

In physical science a first essential step in the direction of learning any subject is to find principles of numerical reckoning and methods for practically measuring some quality connected with it. I often say that when you can measure what you are speaking about and express it in numbers, you know something about it; but when you can not measure it, when you can not express it in numbers, your knowledge is of a meagre and unsatisfactory kind; it may be the beginning of knowledge, but you have scarcely in your thoughts advanced to the stage of *science*, whatever the matter may be.

We fail to find anywhere in the book any clue by which to take "the first essential step" above mentioned, and that this is a defect is apparent. For instance, on page 28 is a very brief note on battery formation, and it is interesting to turn from these very sketchy remarks to Prof. W. E. AYRTON's "Practical Electricity," a book for the same class of readers, and read the clear, simple rules there given for properly arranging cells for any purpose, with selected examples carefully worked out and a graphical solution so simple that it can be used by any one old enough to understand what the term "dynamic electricity" means.

In the hands of a competent teacher, however, the book will prove very useful in high schools and academies. While there are a few theories advanced that look somewhat moth-eaten in the light of our present knowledge, there is nothing that is positively wrong, and there are many subjects that are brought down to date, such as electric welding and storage batteries. The book is a decided advance over the majority of American books of its kind and with a little less ancient history, fewer trade cuts and enough numerical data to enable the reader to know, for example, whether 1 or 12 incandescent lamps are run for each electric horse power, Dr. ATKINSON will produce a work that will probably receive a wide circulation.

—*The Patent System of the United States: A History.* By LEVIN H. CAMPBELL, Asst. Examiner, U. S. Patent Office, Washington, 1891. Published by the author. Paper, 6 × 8 ins.; pp. 55; 4 small cuts; 50 cts.

This unpretentious little volume gives a readable account of the origin and growth of the American patent system. We regret that we can say nothing more favorable for it, since a good history of the American patent system would be a valuable book. The book before us contains neither index nor table of contents, and we have had to look elsewhere for the information which we publish in another column showing the number of patents, rejected applications, etc., issued in each year since 1790. The book contains considerable matter of interest, but it is so poorly arranged that it is about useless for reference.

—*A Description of Some Lower Carboniferous Crinoids from Missouri.* By S. A. Miller, Jefferson City, Mo., Geological Survey of Missouri. Paper, 8vo, pp. 40, 5 plates

—*Biennial Report of the State Geologist of Missouri.* By Arthur Winslow, Jefferson City, Mo., Geological Survey of Missouri. Paper, 8vo, pp. 54, 2 plates.

The first of these pamphlets contains a description of a number of new crinoids discovered in the sub-carboniferous strata of Missouri by R. A. BLAIR and F. A. SAMPSON, of Sedalia. Forty-three species are described and illustrated. The second pamphlet contains an historical sketch of the present and preceding surveys of this State, and outlines the scope and cost of such undertakings. An abstract of a portion of the pamphlet will be given later.

—*Fourth Annual Report of the Interstate Commerce Commission.* THOS. M. COOLEY, WM. R. MORRISON, AUGUSTUS SCHOONMAKER, WALTER L. BRAGG, WHEELOCK G. VEAZEY, *Commissioners.* Washington, 1890. Cloth, 8vo, pp. 443.

The advance copy of this report was reviewed editorially in our issue of Dec. 13, 1890. The appendix to the report contains statements of the points decided by the commission during the year covered by the report, and of the important points decided since its organization; reports upon changes in freight classifications and freight rates of the railways of the United States, and on uniform classification; abstracts of state laws on subjects covered by the Interstate Commerce law; and articles on railway regulation in foreign countries, ticket brokerage, the National Convention of Railway Commissioners, and decisions of U. S. courts holding that witnesses must testify concerning alleged violations of law. The index to the report deserves especial praise for its completeness.

—*Second Biennial Report of the Railroad Commissioners of the State of Oregon.* J. P. FAULL, G. W. COLVIG, ROBERT CLOW, Commissioners. Salem, 1891. Paper, 8vo, pp. 541.

—*Annual Reports.*—The following water-works and other reports have been received, the gentlemen named being superintendents unless otherwise noted: Concord, N. H., V. C. HASTINGS; St. Johnsbury, Vt., E. H. BLOSSOM, Superintendent Highways; Abington, Mass., A. H. WRIGHT; Lawrence, Mass., A. H. SALISBURY; Leominster, Mass., J. G. TENNEY; Maynard, Mass., T. HILLIS, Water Commissioner; Medford, Mass., R. M. LOW; Nahant, Mass., J. COLBY WILSON, Secretary Selectmen; New Bedford, Mass., F. C. P. COGGESHALL; Newton, Mass., H. NELSON HYDE; Waltham, Mass., HARDY BROWN, Clerk Water Commissioners; Danbury, Conn., C. B. MASON; Hartford, Conn., EZRA CLARK, President Water Commissioners; New Britain, Conn., D. A. HARRIS; Gloversville, N. Y., J. B. TUCKERMAN, Clerk Water Commissioners; Lansingburg, N. Y., JOHN GALLAGHER, Chairman Water Commissioners; Ogdensburg, N. Y., A. H. LORD; Bridgeton, N. J., T. WOODRUFF; Dover, Del., T. F. COOKE, Chief Engineer; Newark, Del., JAMES HAYES; Negaunee, Mich., A. BENISHEK; Rockford, Ill., J. T. DAKIN; Minneapolis, Minn., J. H. MCCONNELL; St. Paul, Minn., J. B. OVERTON; Fredericton, N. B., A. BURCHILL; Yarmouth, N. S., GEORGE BINGAY, Secretary Yarmouth Water Co.; Nanaimo, B. C., A. A. RICHARDSON, Secretary Nanaimo Water-Works Co.

—*Annual Report of the Water Commissioners of St. Paul, Minn., Dec. 1, 1890.*—JOHN CAULFIELD, Secretary; JOHN B. OVERTON, Superintendent. Dec. 1, 1890.

Those interested in the details of the financial operations of water-works will find two valuable tables in this report. One of the tables gives the yearly receipts of the works, distributed to 17 accounts, from the time of the purchase of the works by the city, Aug. 10, 1882, to Nov. 30, 1890. The other table gives the total expenditures for the same period, distributed to 40 different accounts.

TRADE PUBLICATIONS.

—*The J. T. Case Engine Co.*—New Britain, Conn., Pamph., 32 pp., 8 cuts.

This catalogue illustrates and describes a somewhat novel type of oscillating cylinder, high speed engine for small powers. The special feature of the engine is its simplicity, the only moving parts being the cylinder, piston, and crankshaft. It is built in a number of different styles for special uses.

—*Surveyors' and Engineers' Instruments.*—T. F. RANDOLPH, Cincinnati. Pamph., pp. 80, illustrated.

The notable things in this catalogue are some light cheap levels selling for from $33 to $50, and several styles of telescope compasses, which seem to be very popular with land surveyors.

—*Milliken Patent Poles.*—Milliken Bros., New York and Chicago. Paper 7 × 11 ins., pp. 30, excellent illustrations.

This firm makes a specialty of metallic poles for electric railway work, electric lamps and line wires. Many of their street railway poles have been illustrated in ENGINEERING NEWS.

—*Pulverizing, Granulating, Drying and Separating Machinery and Apparatus.* Frontier Iron & Brass Works, Detroit. Pamph., pp. 15, with cuts.

The machines described in this little catalogue are claimed to be especially superior for the preparation of either granular or fine products. The dust separators, which dispense with the usual bolting screens should be of especial interest to cement manufacturers.

—*Steam: Its Generation and Use.* Twenty-third edition. New York, 1891, the Babcock & Wilcox Co. Cloth, 7⅛ × 10½ ins., pp. 152.

This latest edition of this now well-known volume, which contains so much technical matter of value that we hesitate to class it as a trade catalogue, is in the same form as the edition reviewed in our issue of Apr. 27, 1889. The new matter inserted includes a lecture on the circulation of water in steam boilers delivered by Mr. Geo. H. BABCOCK before the students of Cornell University and a short formula and table for determining approximately the *relative* capacities of pipes of various diameters for delivering steam, air, or water. The formula is as follows: $W \propto \frac{d^3}{\sqrt{d + 3.6}}$ in which W = the weight of the fluid delivered in a given time and d = the actual internal diameter (which must be carefully distinguished from the nominal internal diameter). Of course the formula does not give the actual amount delivered, but only the relative amount by pipes of different sizes.

—*Improved Hydraulic Jacks.* Catalogue of Watson & Stillman, New York. Pamphlet, pp. 31.

This catalogue, besides including almost every form of portable hydraulic jacks, shows a wide variety of screw jacks tube expanders and screw hoists, as also directions for the care and repair of hydraulic jacks. The dimensions, sizes, lifting power and price are shown in full detail, making it very convenient for reference.

—*Rubber Hand Stamps and the Manipulation of India Rubber.* A Practical Treatise on the manufacture of india rubber and stamps, small articles of india rubber, etc., the hektograph special inks, cements and allied subjects. By T. O'CONOR SLOANE. New York: N. W. Henley & Co., 12mo, pp. 125; 27 illustrations, $1.

The title of this little work is almost too modest. It is really quite a readable and practical little treatise on the manufacture of india rubber in general, and as such can be read with interest by any one, while the special processes to which it is devoted are very clearly and fully handled. The author shows decided capacity as a technical writer, wasting no words and confining himself strictly to what he has to say, yet saying it in admirable form, and so as to convey the impression, at least, that he thoroughly understands what he is writing about, which we have no doubt he does.

SOCIETY PROCEEDINGS.

Eleventh Annual Convention of the American Water-Works Association.

The eleventh annual convention of the American Water-Works Association was held this week at the Continental Hotel, Philadelphia. The meeting was called to order Tuesday morning by Mr. W. B. Bull, of Quincy, Ill. The roll call showed about 60 active and 15 associate members present. After passing the reading of the minutes of the last meeting, Messrs. B. F. Steben, Brockville, Ont., James H. Harlow, Pittsburg, Pa., and R. M. Clayton, Atlanta, Ga., were elected as active members of the Association.

The President, in his address, called attention to the fact that the association has grown from an original membership of 29 to about 300. He also stated that in one respect the association is weak, that is, in the reluctance of the members to contribute papers. As an illustration the President stated that one of the members wrote to him that he would attend this year's meeting without a paper, but in a receptive mind. There is such a thing as a too receptive mind. Papers need not be long in order to be good, neither need they be profound. They may, to advantage, be of a local character, as there is danger of having papers of a general nature which treat the same subjects over and over until it becomes hackneyed.

The president stated that since the last meeting there have been no notable changes in water-works practice, and expressed the idea that in the future improvements would be in the way of better methods. Perhaps the most important subject now before water-works men is that of purification.

Mr. Bull next referred to what he believed to be a growing prejudice against the municipal ownership of water-works and other works of a like nature, and stated that in view of it there is a necessity for great care in the preparation of contracts between companies and municipalities. He added that the Association is therefore fortunate in having before it the prospect of listening to a paper on that subject.

The report of the Secretary and Treasurer, Mr. J. M. Diven, showed the total receipts of the association for the past year, including last year's balance, were $1,564, of which $806 were still in the treasury. Mr. Diven stated that since the last meeting 62 members had been elected, 3 had resigned and 1 had died, leaving the net gain in membership 58.

An invitation from the Engineers' Club of Philadelphia to visit and make use of its rooms was received.

The report of the Committee on specifications for cast-iron coated water pipe was then read by the Chairman, Mr. T. W. Yardley, of Chicago, the other members of the committee being Mr. S. Bent Russell, St. Louis, Mo., and Mr. A. J. Guilford, Chicago, Ill. The paper is published elsewhere in this issue.

A brief paper on the beginning and growth of the Philadelphia Water-Works was next read by Mr. E. Geyelin, of Philadelphia. These works have been so fully described in past volumes of ENGINEERING NEWS, and in the MANUAL OF AMERICAN WATER-WORKS that an abstract of Mr. Geyelin's paper is unnecessary.

TUESDAY AFTERNOON.

At the beginning of the session, Mayor E. S. STEWART made a brief address of welcome. He stated that he had been in office only eight days, but in that time about thirty-five different persons had talked with him about the Philadelphia water supply, each advocating a plan of his own.

The report of the Executive Committee was then read and adopted. The report recommended that the salary of the secretary and treasurer of the association be fixed at $400; that the names of all members who for three years did not perform their duties towards the association should be dropped from the list; and that the secretary be authorized to solicit from associate members advertisements to appear in the annual reports of the association, at a price to be agreed upon between him and them.

At this point a committee on the nomination of officers for the ensuing year reported that the following gentlemen would act in that capacity: L. H. Gardner, William Ryle, H. P. Holden, C. N. Priddy, A. N. Dennison.

The report of the Committee on Animal and Vegetable Growths Affecting Water Supplies was next presented by the Chairman, Prof. Albert R. Leeds, of Hoboken, N. J. The other members of the committee were Messrs. L. J. Le Conte, Oakland, Cal., and L. H. Gardner, New Orleans.

Prof. Leeds reviewed the work of the committee during the year, and stated that, while progress had been made, the work had really but been begun.

The Professor read letters from each of the other members of the committee, in which they stated the experience recently had in connection with their works. At New Orleans Mr. Gardner had had trouble with a grass-like growth, about 4 ft. long, which appeared in the bottom of the small reservoir, to which water is pumped intermittently. The water was finally drawn from the reservoir and the growth removed. Mr. Le Conte's observations were on stored water supplies at or near San Francisco, in connection with which there is trouble from the development of both animal and vegetable matter, beginning in May or June and extending through the summer. The process of development and an extended account of the troubles experienced were presented in a paper read before the association at Chicago last year, entitled "Contamination of Waters in Certain Storage Reservoirs on the Pacific Coast, and the Palliatives Resorted To." (A full abstract will be found in ENGINEERING NEWS of Aug. 23, 1890.)

After reading the communications referred to above, Professor Leeds made verbal comments on answers to inquiries sent to various water-works men to ascertain their experience with the growths under consideration. Several had removed the trouble, or ameliorated it, by cleaning supply mains and reservoirs occasionally.

In studying the growths under consideration, it has been found that they may be classified, oftentimes, in accordance with the organic matter to be found in the water, and upon which the organisms feed. Sometimes chemical treatment of the water, on a large scale, will obviate the difficulty. Prof. Leeds gave an example of the rapid contamination of the water in a reservoir, so that, in a short time, fish died, and the odor of the water was extremely nauseating. Upon examination it was found that the bottom of the reservoir was covered with a carpet of minute algæ, the growth of which he attributed to some volatile matter. Upon trying to distil the water the odor was so penetrating that both he and his assistant became ill, and nothing in this direction was accomplished. Finally, the water was drawn out of the reservoir, lime sown over its bottom and gravel spread above this, all with good results. Some organisms secrete oil, some secrete other matter. The kind of secretion and its antidote must be determined.

A discussion of the report followed, during which Mr. Timothy Woodruff, of Bridgeton, N. J., described a moss-like growth which appeared in a pond at Bridgeton, and grew to a considerable height. The moss decayed and rose to the top in a minute white cloud-like form, the separate particles of which, through a microscope, resemble hair.

Mr. J. H. Decker, of Salina, Kan., related an experience at one of the works with which he is connected, where water is pumped from a river to a reservoir. The reservoir is lined with brick and cement, and was built about two years ago. During last May and June, while the water was what Mr. Decker termed "commercially pure," long grass-like bunches about the size of a bushel basket, but perhaps taller, sprang from the bottom of the reservoir. In each of there bunches there were found from one to two quarts of shell-like growth, the animals within resembling snails. The water had a cucumber smell. It was finally necessary to empty the reservoir, remove the rowth, and scrub the bottom thoroughly.

Mr. Devonshire, formerly connected with the water-works at Antwerp, Belgium, stated that the water supply there is taken from the River Scheldt, passing through a 6 ft. intake, 150 ft. long to a receiving reservoir and thence to a filter bed. In a section of 24-in. pipe, 300 ft. long, through which the water passed to a filter bed, a green growth appeared in the lower part of the pipe. The pipe was not kept filled and the growth was in the wetted part only. The pipe was finally kept clear by flushing with water under pressure.

Interspersed with the relation of experiences given above were remarks by various members in favor of having the work of Prof. Leeds' committee continued, especially in connection with committees from other associations interested in pure water. This discussion was joined in by Mr. L. H. Gardner, the President, Mr. G. H. Benzenberg, Milwaukee; Mr. R. C. P. Coggeshall, of New Bedford, Mass., and Mr. Hawes, of Fall River, Mass. The President spoke of the recent work of the American Society of Civil Engineers along this line, and of their wish that the association appoint a committee to co-operate with them. Mr. Benzenberg referred to a recent voluminous paper on this, or an allied subject, prepared by Dr. Currier, and read before the American Society of Civil Engineers. He thought the paper, while exhaustive from a historical point of view, presented no new matter, but added that the discussion brought out some fresh ideas. If the Society and the Association would consider the matter together, he thought the National Board of Health would join. He said that many municipalities and water companies are investigating the subject, that he was interested in it, although Milwaukee draws upon a great lake for its supply, and that he thought Chicago was be coming interested. In conclusion, he thought that the Association could do nothing which would so much advance its interests as to make an appropriation to carry on the investigation.

The President remarked that the New England Water-Works Association should properly be invited to appoint a committee to co-operate with the others. Mr. Coggeshall stated that he would take pleasure in bringing up the matter at the next New England meeting. Mr. Hawes thought that the opinion that ponds and other sources of water supply should be considered as primarily for the sanitary use of the people was growing stronger and stronger in all State legislatures. Mr. Gardner finally made a motion, which was carried, to the effect that the President should appoint a committee of three, on this subject, with Professor Leeds as Chairman, which should co-operate with the National Board of Health, the American Society of Civil Engineers and the New England Water-Works Association.

The next paper on the programme was "Riveted Steel Pipe," by Mr. D. J. R. Duncan, Managing Director of the Steel Pipe Co., of Kirkaldy, Scotland. The paper being long, the writer absent and copies for distribution being available, its reading was dispensed with.

The next paper in order, "The Columbus, O., Water-Works," not being at hand, Secretary Diven began the reading of a paper by Mr. J. Nelson Tubbs, of Rochester, N. Y., entitled, "Is the General Application and Use of Meters Advisable in Supplying Potable Water to Consumers? and Will the Practice Prove Remunerative to the Owners of the Works?" It is abstracted elsewhere in this issue.

The afternoon session practically closed with the above paper.

THE BANQUET.

A reception and banquet were given to the members and their wives at the Manufacturers' Club, Tuesday evening. The affair was under the direction of the local committee, of which Mr. J. L. Ogden, Chief of the Philadelphia Bureau of Water, was chairman. Mayor Stewart was present to add still more to the words of welcome given in the afternoon. The evening was very enjoyable, both the house of the club and their entertainment giving evidence of the enterprise, good-will, good taste and hospitality of the manufacturers of Philadelphia.

WEDNESDAY MORNING.

The session opened with the election of Robert Surtees, Ottawa, Ont., George Hilyer, Atlanta, Ga., and John B. Hawley, St. Paul, Minn., as active members, and the Walworth Manufacturing Co., Boston, the City Water Board, Wheeling, W. Va., the Brass & Iron Works Co., Fostoria, O., Morris Tasker & Co., Philadelphia, as associate members. Invitations were received to visit the permanent exhibition of the Builders Exchange, and the works of William Cramp & Sons, ship and engine builders.

An amendment to section 2, article 3, of the constitution was introduced by Mr. L. H. Gardner for the Executive Committee to the effect that active members who change their vocation to one which would naturally class them with associate members, be relegated to that first. After some discussion the following substitute, offered by Mr. G. H. Benzenberg, was adopted:

Any active member of this association who may at any time change his vocation may continue as an active member with all the privileges of that class, with the exception that he shall not be eligible to any office in the association while thus engaged.

The first paper of the morning was by Mr. Wm. Rienecke, of St Louis, on "Water-Works Securities." The paper called attention to the fact that water-works securities are now held as investments by conservative parties, one insurance company having had at one time $1,500,000 of these securities. The fluctuation in value of railway securities was referred to at some length, and was contrasted with the steady and often increasing value of water-works, stocks or bonds.

In conclusion, Mr. Rienecke named the following points which should be considered in connection with investments in the securities of water companies: The legal authority of the municipality to grant a franchise and to contract for hydrants and its ability to pay the rental, should be made sure of. The works should be built, tested and accepted before purchasing securities. The annual interest on the bonds should not exceed the annual hydrant rental. The bond issue should not exceed the cost of the works. The revenue from consumers should be sufficient to meet all expenses besides interest. The bonds should mature before the expiration of the hydrant contract.

Referring to the above paper, Mr. C. B. Brush, of Hoboken, N. J., said that he believed that the revenue from hydrants could not in the future be relied upon to meet interest charges, as the tendencies are to lower hydrant rental, owing to the rapidly increasing revenues from private consumers. Therefore in future improved methods and increased revenues from consumers must be depended upon rather than hydrant rentals.

Mr. Brush then read a paper entitled "Aëration of a Gravity Supply," which we reprint elsewhere.

In the discussion which followed, Mr. Brush stated that the use of aëration was very old. The President asked if the passage of the air which is forced into the main interfered with the passage of water by the collection of air? Mr. Brush explained that no air collected in the pipe. He added, that in connection with his Hoboken works, he has summits at 75 ft. elevation, from which he blows out air when necessary.

A paper on "Value of Pressure Records in Connection with Water-Works" was then read by Mr. C. A. Hague, of New York. The paper gave many instances of the value of such records, both because of their saving to machinery and to the reputations of those in charge of pumping machinery. By the aid of the blackboard he showed typical record cards for different conditions.

A discussion followed, during which Mr. Brush asked how many gages were in use at St. Louis, Mr. Hague having referred to gages there. Mr. Hague stated that the number was not large, but that one gage was moved about to detect troubles at various points. Mr. J. C. Chase, of Wilmington, N. C., said that on an ordinary system many benefits could be derived from one gage. Mr. J. H. Decker, of Salina, Kan., gave an experience where the gage showed a variation of about 10 lbs. pressure from noon until 10 P. M. An examination showed the need of repairs to the pump.

Mr. Denman related his experience with gages. He said that they were introduced in 1883, and revealed such tricks and practices among those in charge at the pumping station, that within three months he replaced them all with new men.

Mr. Chase said he would be pleased to mail to all who wished them cards from his works. He also said that attached to his gage he had an extensive apparatus connected with the city fire alarm, which recorded the exact time at which each alarm was given.

The last paper on the morning's programme was on "Water-meters, Cost of Setting and Maintenance," by Mr. Edwin Darling, of Pawtucket, R. I. Owing to a death in his family, Mr. Darling was not present, and, as his paper had not arrived, the meeting adjourned until the afternoon session.

WEDNESDAY AFTERNOON.

Messrs. Phil Carlin, of Sioux City, Ia.; C. T. McLain, Syracuse, N. Y., and C. E. Bolling, Richmond, Va., were elected active members, and the Holyoke (Mass.) Hydrant & Iron Works (represented by T. S. Parsons), and S. L. Morrison, of the Morrison-Allen Co., New York, as associate members.

After this came a paper by Mr. B. F. Jones, Kansas City, Mo., on "Hydraulic Elevators: Objections to Their Use by Water-Works, and Advantages to the Public by Their Use." Mr Jones stated that at Kansas City there are now 43 passenger and 121 freight elevators working under direct pressure, and 65 elevators working under tank pressure, making a total of 229. Mr. Jones gave two objections to large openings in the mains, the first being that in case of a fire destroying the building the connection would probably be broken and large and unpreventable waste would ensue. The second objection is that water hammering is likely to result. In 16 years' experience Mr. Jones stated that he recalled but one instance in which the breaking of elevator connections had any appreciable effect upon the pressure. In view of local conditions the making of new connections for direct pressure elevators at Kansas City has been discontinued. All things considered, Mr. Jones thought that the tank system is the most desirable for a water company, and direct pressure, in small establishments, the best for the consumer. In the case of large consumers there is little choice between the systems.

A long discussion followed the paper. Mr. Benzenberg stated that there were in use at Milwaukee 600 elevators. He was in favor of the tank system.

Mr. Wagner, of Rome, Ga., stated that in connection with his works there are 2 passenger and 6 freight elevators. Water is pumped to a stand-pipe, which is between the pumps and the elevator referred to below. The elevator is in a hotel with a 6-in. connection, reduced to 4-in. at the elevator, with an 8-in. main. After this elevator had been in operation 4 weeks all, or nearly all, the dead ends within 4,000 ft. were blown out. Mr. Wagner asked the members present to advise him how he could avoid such trouble. Several members agreed in the opinion that an air chamber in connection with the elevator would obviate the difficulty. Secretary Diven thought that water-works were not built large enough to warrant the supply of power, and questioned whether it would pay to build them large enough. Mr. Peter Milne, Jr., of New York, expressed himself as against the use of direct pressure for elevators unless a large supply of water with ample head is available.

Mr. Jarvis B. Edson, of New York, suggested the possibility of inserting, in mains liable to strain from water hammer, a length of vulcanized rubber, to allow for extension, the rubber to be encased with iron.

Mr. Denman believed in hydraulic elevators, both from a financial and sanitary standpoint. As a matter of profit he believed that nothing would pay better, if the capacity of the works would admit of their use, especially when the revenue from one elevator would pay for all the coal consumed at the station, as was the case with one elevator at Des Moines. He said that at Des Moines there were between 30 and 40 elevators in use.

Secretary Diven said that the use of hydraulic elevators necessitated larger plants, and he did not think they paid. The cost of coal, alone, referred to by the preceding speaker, was a small item. The increased cost and fixed charges for the whole plant must be considered.

Mr. Chase believed in furnishing water to every one who would pay for it. Mr. Milne said that at Liverpool the Hydraulic Power Co. was bringing in water from a point 9 miles distant to supply hydraulic power only, and that to-day there were 7 miles of docks in Liverpool where the only power used is hydraulic.

Mr. Benzenberg thought that water departments should establish a rule limiting the size of the openings for elevator connections and the number to a square. They had reached a point in Milwaukee where this was necessary. They had been obliged to replace some mains with larger ones, in order to satisfy large consumers. There had been no trouble with water ram on account of the elevators, although they had about 600 in use. He thought so many elevators, some using water and others not, tended to equalize the pressure. Mr. Gardner asked the amount of pressure at Milwaukee, and was informed that in the business district it is from 50 to 57 lbs., and that the smallest main used is 4 ins. in diameter. Mr. S. E. Babcock, of Little Falls, N. Y., wished to know what income was derived per elevator, and was informed that it ranged from about $125 to $800.

The president next read an invitation to visit the works of the Southwark Foundry & Machine Co. The executive committee announced the continuance of Prof. Albert Leeds, and Messrs. L. J. de Corte and L. H. Gardner as committee on animal and vegetable growths affecting water supplies; these gentlemen to co-operate with similar committees from other bodies as voted on Tuesday. The sum of $100 was appropriated to partially defray the expenses of Prof. Leeds in his work for the committee last year. The making of further appropriations for the committee was referred to the executive committee with power.

A paper on "The Necessity of More Accurate Knowledge of the Flow of Water in Pipes, and Some Experiments with Water Hammer" was read by Mr. J. B. Rider, of South Norwalk, Conn. Mr. Rider treated the subject fully, reviewed different formulas for the flow of water and compared experiments with the results which should have been obtained according to the formulas, the discrepancies being considerable. There was no discussion.

The last paper of the afternoon was on the importance of a more uniform system of water rates, by Mr. H. G. Holden, of Nashua, N. H. The paper referred to family rates, and suggested that charge should depend upon the size of the family rather than the number of rooms, size, height or value of the house. The charges for water closets should be moderate, providing an approved pattern was used, but, otherwise, they should be double the usual rate. Generally there was but little waste from bath tubs, but there was much waste from the use of garden hose, and charges should be made accordingly. As for the other fixtures, little could be said.

In the discussion which followed the method of fixing charges in several cities was discussed, showing as many methods as cities. Mr. B. F. Steben, of Brockville, Ont., expressed himself as in favor of meters.

Mr. Holden stated that at Nashua, N. H., there were less than 100 meters in use, and none for private families. Where the supplies are limited, he believed in the use of meters, but not otherwise if it could be avoided.

WEDNESDAY EVENING.

At the opening of the session, Secretary Diven read a bill, now before the Pennsylvania Legislature, giving the State Board of Health supervision over streams used fo

public water supply. A resolution approving the general principles of the act was passed by the association.

The question, "Who Should Own the Meter," was then discussed. Mr. L. H. Gardner read a brief paper favoring ownership by the consumer.

Mr. Decker, who read a paper on this topic at the last convention, thought it mattered but little who pays for the meter, nominally, as its cost eventually falls upon the consumer. But, in brief, he believed that the meter benefits the consumer, and should be paid for directly by him, especially in case of public ownership of works, where the cost of meters, if not met by the consumer benefited, would be paid by the city at large, some of whose inhabitants do not use water.

Mr. Milne spoke strongly in favor of the city or company owing the meter, as the water-works' management places, inspects and repairs the meter, and it is properly a part of the system.

Mr. J. E. Booker, of San Francisco, said that there the company owns the meters, and has $250,000 invested in them. The company is obliged to use meters because of the scarcity of water, and is obliged to own the meters.

To reduce waste he said that the meter was good, but to secure income he thought it was not good. In San Francisco there are now 12,000 meters in use, and the consumption is but 68 galls. per capita. The old style of Worthington meter is used, and the meters are now made by the company, as the patent has expired.

Mr. Phil. Carlin, of Sioux City, Ia., stated that in his city 2-in. meters were paid for by the consumers in instalments of 40 cts. a month, and the expense of repairs met by the consumers.

Mr. J. P. Donohue, Davenport, Ia., said he thought that in all fairness the company or city should own the meter.

M. George Hillyer, of Atlanta, Ga., thought that the principal question was how to secure the adoption of meters. In case of a city it was easier to secure the adoption of meters if paid for by the consumers.

Mr. Chase remarked that heretofore the use of meters had not been considered from an engineering standpoint in the construction of works and the expense of meters included in the cost of construction. He thought that the meter should be owned by the owners of the works, and that it would pay as an investment.

Mr. Milne stated that, in the case of New York, had the general introduction of meters been stated before beginning the construction of the new aqueduct, the work might have been accomplished for $8,000,000, thus making the new aqueduct unnecessary, and saving $18,000,000.

Mr. Phineas Ball, of Worcester, Mass., said that city had used meters for 20 years, but unfortunately it adopted the plan of consumers owning the meters. The city officials had adopted the makeshift of repairing all meters free of cost instead of replacing the old ones with new. After some remarks, the question box and volunteer papers were disposed of. The only question presented referred to the appointment each year of a committee of three to examine and report upon the exhibition made by associate members. The matter was left with the Executive Committee. After the distribution of printed copies of a volunteer paper by Mr. J. T. Fanning, of Minneapolis, on the Versailles water supply the meeting adjourned.

THURSDAY.

At the morning session, the reading of papers was finished, leaving the balance of the day and Friday for the election of officers and other business and the excursions arranged by the local committee. The papers read at this session were, "The Purification of Water by Metallic Iron," by Dr. Henry Hoffman, of Philadelphia, and a paper on "Water Motors, Cost of Running and their Economy," by Mr. S. E. Babcock, of Little Falls. At this meeting J. M. Diven was elected President and J. H. Decker Secretary for the ensuing year. Two new members were admitted, and it was voted to hold the next convention in New York.

In the afternoon, members of the association visited the Philadelphia water-works.

Further proceedings of the meeting, the details of Thursday's proceedings and mention of the exhibition by associate members, will be given next week.

New England Railroad Club.—At the meeting on April 8 a paper was presented by ANGUS SINCLAIR on "Inspection of Air Brakes of Freight Cars." It is abstracted, with the discussion, in another column. At the May meeting the subject for discussion will be "Rules for the Interchange of Freight Cars." Messrs. F. D. ADAMS, J. W. MARDEN and J. P. CHAMBERLAIN were appointed a committee to report at that meeting such changes as they think expedient in the rules.

Civil Engineers' Society of St. Paul.—The third joint meeting of the engineers' societies of St. Paul and Minneapolis was held April 6. Mr. F. W. Cappelen read a paper on "The Minneapolis Suspension Bridge. The first bridge across the Mississippi River was a 590 ft. span suspension built in 1854 and replaced by the structure under consideration in 1876. The second bridge was taken down in 1889 to make room for the present steel arch bridge, the woodwork being completely wrecked by dry rot. The cables were taken down, wire by wire, each one being pulled from its place and coiled on a drum by steam power, at an average cost of 20 cts. per wire, or a trifle over ¼ ct. per lb. About 1,421 miles of wire were thus wound. Mr. Cappelen next demonstrated that the loaded cables assumed the form of a parabola instead of the catenary curve. The cost of demolishing the bridge was $11,000. The anchorage irons, although embedded in cement, were found deeply corroded. The discussion brought out the fact that the wooden bridges of this day and vicinity are built of green lumber, which should not be painted (except at the joints) until thoroughly seasoned; and that oak keys for pin timbers may be wrapped in tarred paper to advantage.

Liverpool (England) Engineering Society.—At the meeting on March 18 there was a discussion of the paper read at the previous meeting by Prof. Hele Shaw on "The Education of an Engineer." The President, in opening the discussion, stated that he thought the preliminary education of an engineer should be as broad as possible, and urged in particular the value of the study of the higher mathematics. He also referred to the value of scientific societies. Mr. George Farren referred to the continental system of training, and gave particulars of various courses of studies adopted in the government schools in Holland for the preparation of engineers. Mr. Henry H. West protested against the "half-time" system of training, by six months' college and six months' work, and advocated the old-fashioned principle of five or seven years' apprenticeship in the shops or office, and suggested that this should be followed, if possible, by two years of college training. Mr. A. Higginson was, from experience with his own apprentices, in favor of the "half-time" system. Mr. J. H. T. Turner thought that the student should first be brought face to face with the commercial aspect of his profession, and later on, when he has seen what is actually done in the shops and office, in the field or on works, then let him give some time to scientific study of the principles that underlie what he has seen practiced. Mr. Robert E. Johnston looked upon technical engineering colleges as extremely valuable, and spoke as to the value of technical education to the artisan class. Mr. Coard S. Pain spoke in favor of the present English system as against the Continental system.

American Society of Civil Engineers.—At the meeting on April 15, Mr. E. P. North in the chair, the Secretary read a paper by Mr. A. McL. Hawks on "The Colorado Automatic Refrigerator System, at Denver, Col.," describing an interesting and commercially successful experiment in furnishing a refrigerating medium through mains, which has been in operation for nearly two years. The process consists in the forcing of ammoniacal liquor through the main, the sudden increase of space at the point where refrigeration is required so that the liquor can vaporize quickly, and the absorption by water to return it by a suction main to the central station; and the redistillation of the ammonia. The company put in its plan in March, 1889. This plant consists of a 30-ton ice machine, about two miles of 1-in. wrought iron main with connections for 29 boxes, having an air space of 70,000 cu. ft., and a cold storage warehouse of 50,000 cu. ft. capacity. The valves in the boxes have an opening of ¾-in. Beyond the valve is a grill of 1½-in. pipes on the ceiling of the room, connecting with the 3-in. return main. Various automatic devices are being put in to facilitate the working of the plant. Contracts are made on a schedule of exposed surface and openings.

Mr. C. P. Bassett read a paper on "Inland Sewage Disposal, with Special Reference to the Works at East Orange, N. J." After dealing with the subject generally he described the East Orange works, and their operation, particulars of which have been given in ENGINEERING NEWS, Nov 24, 1888, Jan. 5 and 19, 1889, and Feb. 15, 1890. Some of the conditions are unfavorable, and the results have not as yet been entirely satisfactory. Mr. Hering, in the discussion, thought the cost of operation, about $1 per head per annum, to be too high.

Central Railway Club.—At a meeting at Buffalo on April 8 a committee report on the inspection and repair of air brakes was presented by Mr. E. D. Bronner. It was recommended that the rules of interchange provide for the refusal of cars with the brake apparatus out of order, and a list of defects was given for which the cars might be refused. A list of repairs which might be made and bill rendered to the owner was given as follows:

Cleaning and oiling triple valve, cleaning and oiling cylinders, taking up slack in connections, putting new rubber seat on emergency valve when necessary (when leather seat is found it must be replaced by rubber seat in all cases), 50 cts. This price to cover the first three items or all four.

Repairing leak in main pipe when sections of pipe must be removed, 25 cts.

Repairing triple valve gasket, 30 cts.

Whenever triple valves are cleaned or tested, and brake cylinders are cleaned or oiled, the date is to be chalked on the auxiliary reservoir and on the brake cylinder.

It was further recommended that each road have at one or more points a special siding, with apparatus for testing and repairing air brakes. The following classes of air brake cars should be switched onto this track:

Home road cars which have not had cylinders oiled for over 3 months, or the triple valve or the cylinder cleaned for over 6 months, except cars of above class loaded with stock, perishable, or time freight.

Home cars with brakes defective or inoperative from any cause, except cars with stock or time freight.

Foreign cars with brakes defective or inoperative, except as above, or which have not had brakes tested since delivery from connections.

All cars, both home and foreign, with brakes inoperative, which have been passed on account of perishable or time freight or live stock, as soon as unloaded, should be put on the test track; and so should all empty cars which have not been on the test track of the road within 3 months.

The club then discussed amendments to the Rules of Interchange. Among those recommended was a provision that a uniform uncoupling attachment be adopted for all automatic couplers, and that the makers of automatic couplers be required to stamp their name on each knuckle in a conspicuous place. It was also moved by Mr. Mackenzie, and carried by a vote of 14 to 5, that any defect in the M. C. B. coupler be accepted in interchange, provided it does not interfere with the effectiveness of the coupler.

Engineers' Club of Philadelphia.—The regular meeting was held April 4, President Lewis in the chair.

Prof. H. W. Spangler, referring to the paper of Mr. Kneass on the flow of steam, called attention to the fact that while steam passes through an orifice at approximately a constant velocity, if an opening is made below the water level of a boiler, the quantity of water passing out under any pressure in unit time is practically constant. This is due, of course, to the fact that as the water passes from the boiler into a passage in which there is less than boiler pressure, a portion of the water is converted into steam, and while the velocity in this case is different for different pressures, the total quantity of water is practically the same at all pressures. In other words, as long as the pressure in the boiler is practically constant, the time of emptying the boiler is always the same through the same orifice.

Mr. Thomas G. Janvier read a paper on "The Engineering Features of The Road Question." This branch of the road question should be divided into three parts: 1st, location; 2d, preparing the road-bed; 3d, laying the pavement. Location.—The item of expense should be well considered. In this connection, grading, land damages, etc., should not be overlooked. The line should be as direct as possible, remembering that a slight deflection to the right or left or an easy curve, might save considerable expense in the matter of excavation, embankment or bridging. The grades should be made as easy as possible, not exceeding 7 ft. per 100 ft., or less than 8 ins. per 100 ft. Excessive excavations and embankments should be avoided. The full width should not be less than 40 nor more than 60 ft., but the paved portion need only be 18 to 24 ft. The road-bed or sub-grade should have the same shape as finished grade. Pavement.—If intended for very heavy travel the telford pavement should be put down, but if for ordinary travel macadam will answer. The difference in cost of these two pavements is but slight, and the telford, being much superior, should be given the preference. A telford or macadam road thoroughly constructed and properly maintained will never need reconstruction. The best system of maintenance is that of constant daily attention and repairs. All dirt roads intersecting a paved road should be paved several hundred feet from the intersection in order that as little mud and dirt as possible shall be carried on to the paved road. Important points to be observed for keeping a road in good condition: All dirt and mud removed as frequently as possible. The entire drainage system carefully maintained. Constant daily repairs and patches, wherever and whenever ruts or depressions begin to show. Careful sprinkling three or four times a day in dry weather. The frequent use of a 2½-ton roller.

Mr. E. V. d'Invilliers, by request of the author, Mr. C. R. Claghorn, of Birmingham, Ala., presented a paper entitled "An Economical Review of the Alabama Coal Fields." There are three principal coal fields, the Warrior, Cahaba and Coosa, all exhibiting a southwest pitch or slope. The special features of the Warrior field, 7,810 square miles in area, are: 1. A tendency in all coal seams to thin going northwest from the southeast outcrop, a line of average thickness crossing the field diagonally in a northeast and southwest direction. 2. An increase of hardness in same direction with a corresponding decrease of coking properties, so that the typical coking and smithing coals are mined along the southeast outcrop, while the best domestic and shipping coals come from the centre and west. 3d. A nearly constant chemical composition, commercial lots averaging: fixed carbon 55 to 63%; volatile matter, 28 to 34%; ash, 5 to 10%, and sulphur, 0.5 to 2%. The moisture in all Alabama coals is low. The Cahaba field, as at present developed, produces the best "all-around" fuels in the state, but in the northern end of the basin the coal appears dirty and slaty, and the productive areas in the south end are quite limited by reason of high dips and the broken and disturbed condition of the measures. The Coosa field has only two active operations, which, in point of production, are of minor importance. The coking coals of the district will naturally continue to be drawn from the present developed areas. The needs of the district for domestic and steam coal will best be subserved by the construction of a north and south railway from Tuscaloosa, passing through the heart of a rich coal area, where the measures are thickest, coals situated favorably for economical mining.

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COMING TECHNICAL MEETINGS.

Engineers' Club of Philadelphia.—April 18. Secy., Howard Murphy, 1122 Girard St.

Western Railway Club.—April 21, "Improvements in Locomotive Boiler Construction, M. C. B. Interchange Rules." Rooms, Phenix Building, Chicago. Secy., W. D. Crosman, 816 Rookery Bldg.

Engineers' Society of Western Pennsylvania.—April 21. Secy., S. M. Wickersham, Pittsburg, Pa.

Boston Society of Civil Engineers.—April 22. Secy., S. E. Tinkham.

Denver Society of Civil Engineers.—April 28, "Colorado Irrigation Laws." Secy., Geo. H. Angell.

Association of Civil Engineers of Dallas.—May 1. Secy., E. K. Smoot, 803 Commerce St.

Northwest Railroad Club.—May 2. Secy., H. P. Robinson, St. Paul, Minn.

Civil Engineers' Society of St. Paul.—May 4. Secy., C. L. Annan.

Engineers' Club of St. Louis.—May 6. Secy., Arthur Thatcher, Room 801, Odd Fellows' Building.

American Society of Civil Engineers.—May 6. Annual meeting, May 20, at Lookout Mt., Tenn. Secy., Francis Collingwood, 127 E. 23d St., New York.

Western Society of Engineers.—May 6. Secy., J. W. Weston, 230 La Salle St., Chicago.

Engineers' Club of Minneapolis.—May 7. Rooms, Public Library Bldg. Secy., F. W. Cappelen.

Technical Society of the Pacific Coast.—May 8. Secy., O. von Geldern, 819 Market St., San Francisco.

Engineers' Club of Kansas City.—May 11. Rooms, Baird Building. Secy., H. Goldmark.

Civil Engineers' Club of Cleveland.—May 12. Secy., A. H. Porter, 50 Euclid Ave.

Civil Engineers' Association of Kansas.—May 13. Secy., J. C. Herring, Wichita, Kan.

New England Railroad Club.—May 13. Secy., F. M. Curtis.

Engineering Association of the South.—May 14. Secy., Olin H. Landreth, Vanderbilt University, Nashville, Tenn.

Northwestern Track and Bridge Association.—May 15. Secy., D. W. Meeker, St. Paul, Minn.

Engineers' Club of Cincinnati.—May 21. Secy., J. F. Wilson.

New York Railroad Club.—May 21. Rooms, Gilsey House. Secy., H. G. Prout.

WE are in receipt of the following brief letter from Mr. D. McN. STAUFFER, dated Greytown, Nicaragua, April 3, and giving some further details of the wreck of the steamer Aguan on Roncador Reef, with President WARNER MILLER'S party on board, and of the general appearance of what will hereafter be the base of supplies for the canal work on the Atlantic coast, where the heaviest work is to be done:

We got here this A. M. after the wreck of the Aguan on Roncador Reef, of which you have already heard. We were stranded for six days on that coral reef, 300 miles from the mainland, and, while the affair might have been very serious with heavier weather, as it was, we simply had to rough it a little, so that we can hereafter appreciate the stories we hear of similar occurrences. Our grounding was due to the still weather, in fact, the sea was so quiet that the usually roaring reef gave no warning by its breakers. Our speed was so slow and the sea so quiet that there was no great alarm on the ship after it struck; but we were rescued in good time, as two or three days more would have meant trouble. Both water and food would have given out, and as the crew and third-class passengers had looted the cargo and obtained supplies of Jamaica rum, they were already becoming troublesome neighbors.

All looks well here, so far as I have seen, 10 ft. of water on the bar, and 2 dredges at work on the canal. The weather is charming after the sojourn on that sandbar. We are in the town of America, facing the sea, and the whole outlook, buildings and general comfort, suggest Long Branch rather than Nicaragua. We start to-morrow, I understand, for our trip over the line to see what we can see.

Several of the correspondents who accompanied the party have sent long descriptions of the wreck, but they add little to the above account. The reef has been a fruitful cause of shipwreck, and remnants of three previous wrecks were still visible on the reef. Its special danger arises from the fact that there is a strong current from the southeast, of 2½ to 3 knots per hour, for which it is difficult to make proper allowance. It is an ill wind which blows no good, and this wreck will possibly lead to the erection of a lighthouse on the reef by the United States government. The reef is six to eight miles long, and ends in a low sandy island about 900 ft. wide and 1,600 to 1,800 ft. long, on which there were a few stunted plants, and the remnants of a rude "fort" of coral, supposed to have been built by the old Spanish buccaneers, as it was evidently planned for defense.

IN an address before the American Geographical Society on Monday last, Civil Engineer R. E. PEARY, U. S. N., gave a most interesting and detailed account of what he intends to do in his forthcoming expedition to the "northernmost point of Greenland," and how he intends to do it. His hope of reaching a more northerly point than man has ever reached before (beyond which he does not express any hope) rests entirely upon the novel route which he has adopted, and by which he hopes to avoid all the frightful hardships and uncertainties which have attended prior expeditions in the same latitudes, which have followed the water routes. This route, as has been before noted, is to strike inward and upward from the coast at once, until he reaches the vast interior ice-field, which is an unbroken and nearly level plain, 7,000 to 10,000 ft. above the sea, with just slope enough to its surface to cause a glacial flow. The ice-field covers the entire surface thousands of feet deep except a few high mountain-tops near its edges, and is itself covered with a deep, unbroken coating of light "sandy" snow, in which shelter from storms can be quickly improvised by burrowing, and over which sleds and men shod with "skies" (long wooden snowshoes) can travel with great ease and rapidity, sometimes even sailing when there is a favoring wind. Mr. PEARY, therefore, looks forward with confidence to following this ice-field to its end, wherever that may be, without any serious difficulties or dangers; and beyond that he is careful to state that he has no expectations. He will land at Whale Sound, about 76° N., in June or July, there spend the rest of the summer and the coming winter in making preparations, establishing caches, etc., and early next spring will start on his trip of some 660 miles and return, as now estimated (assuming the northern extremity of Greenland to be not farther north than 85° N.); which Mr. PEARY estimates can be easily accomplished in some 66 days. The most northerly point ever before reached by man is that attained by LOCKWOOD, of Gen. GREELY'S party, 83° 24′ N.

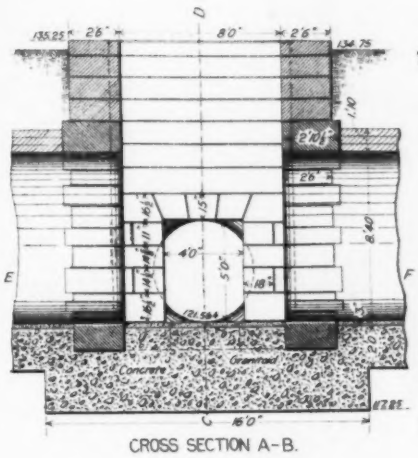
SHOULD Mr. PEARY accomplish no more than this, it will be a great achievement indeed, which will make his name immortal in the annals of Arctic discovery; but if any one will glance at a good circumpolar map, like that which accompanies the article "Polar Regions" in the Encyclopædia Britannica, he will at once see that there are possibilities of a much more startling character. If Mr. PEARY'S method of traveling should prove as effective as he believes it will and as past experience indicates, and if the solid ground of Greenland should happen to reach far enough north, his northern journey may not terminate until he reaches the pole, nor, by his own calculations of probable rate of travel, will it need to do so. The inference that the northernmost point of Greenland is at about 85° N., rests entirely upon the fact that the known portions of the east and west coast stand at an angle of about 90° to each other in their general trend, so that these lines, if continued, would cause them to intersect at about 85° N., to which may be be added the further fact that the archipelago of islands north of British America seems to indicate corresponding conditions in the unknown regions farther north. But, on the other hand, topographical inferences of this kind are most uncertain, and it is almost equally possible that Greenland extends over to Franz Josef Land, north of Russia, and to the pole itself, or so near to it as to open an easy road thereto. Reaching the pole, as such, is of course of only sentimental importance, but the knowledge of the earth's surface which reaching that point implies is by no means of such small importance; and we may be sure that the efforts of daring and adventurous spirits to reach it will never stop so long as a possible road to it remains to be tried of such apparent promise as that which Mr. PEARY will be the first to try. He will carry with him in his journey the good wishes of the whole world, and the confidence of all who know him that what man can do he will do to explore all the unknown region that is explorable.

THE paper by Mr. YARROW, the English torpedo boat builder, on the construction of boilers suitable for forced draft, which we conclude in this issue, is a notable contribution to the literature of the some what neglected art of boiler construction. In England the paper has excited great interest, for the problem of which Mr. YARROW claims to give a fair solution in this paper is one in which every Englishman feels a deep interest. The dismal breakdowns of boilers in Her Majesty's ships, when working under forced draft, have been a greater blow to the British navy than the failures of the 100-ton guns.

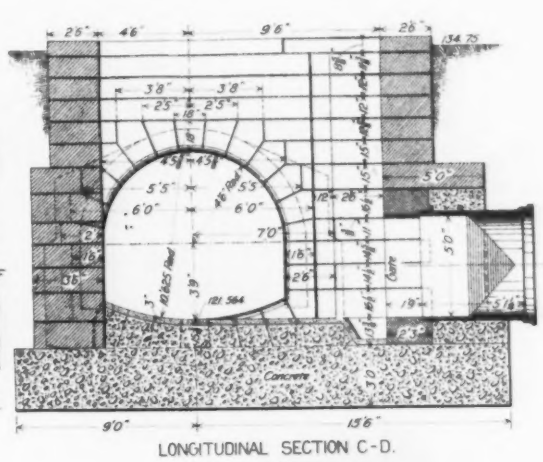
Mr. YARROW rightly says that the locomotive engineers are the ones who have had the largest experience with forced draft, and he credits locomotive practice with a considerable number of the improvements which he has found useful in overcoming difficulties with leaky tubes. His most important recommendation is doubtless the use of thin tube-plates. He recommends a tube-plate no thicker than ½ in., and can see no reason why ⅝ in. would not be better yet. In locomotive practice in this country, ⅝ in. to ½ in. is the usual thickness of tubeplates.

Mr. YARROW brings out in a very interesting manner the contrast between the achievements of locomotive and marine engineers in the use of forced draft. The locomotive boiler, when hard worked, may have an air pressure of as much as 10 ins. of water, including the pressure at the front of the ash pan, as well as the vacuum in the smokebox. But the forced draft used in marine practice has generally a pressure of not more than 1½ to 2 ins. of water. Yet the marine boiler fails in a short time, while the locomotive boiler is good for a daily service of many years; and the failure of the former does not appear to be due to the peculiar service in which it works.

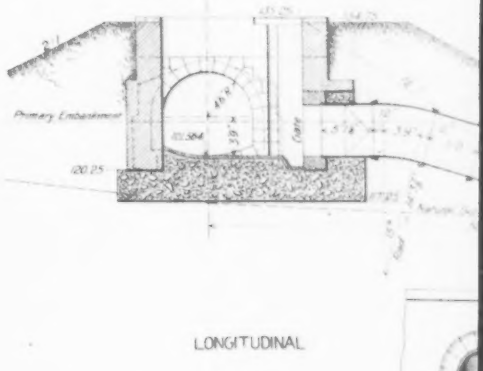
In one particular in which the locomotive practice of England and America is divergent, Mr. YARROW, as is quite natural, follows the practice of his countrymen. We refer to the use of copper, instead of steel, for internal fireboxes. He attempted to prove the correctness of this position by an experiment, in which he showed that a



CROSS SECTION A-B.



LONGITUDINAL SECTION C-D.



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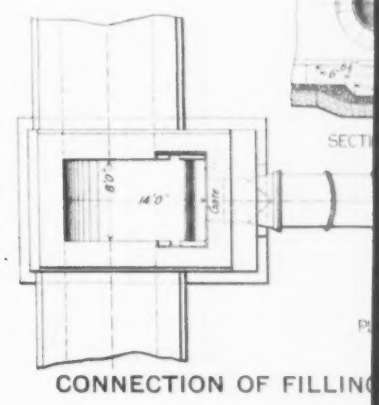
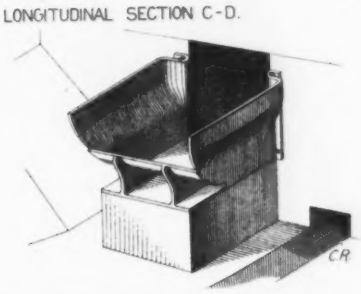
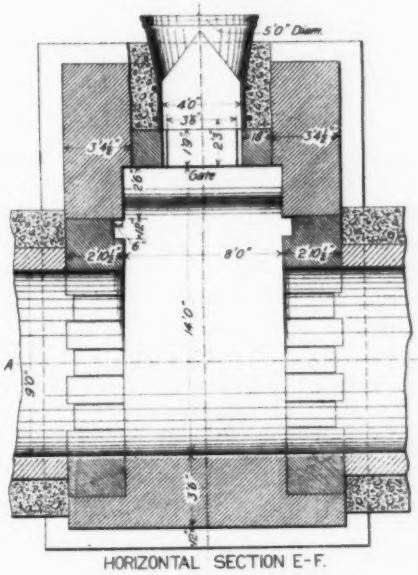


CONNECTION OF FILLING

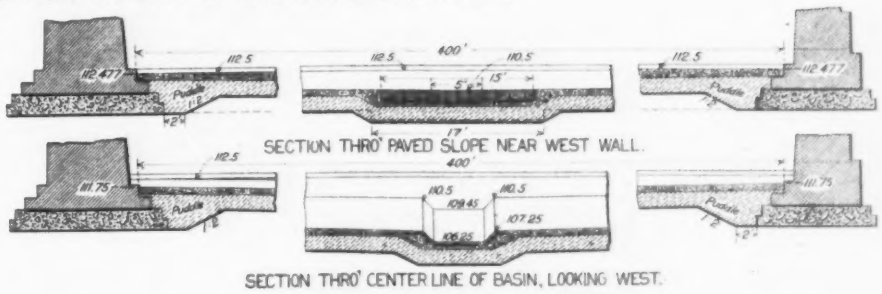


CASTING FOR MOUTH OF DRAWING CHAMBER.



HORIZONTAL SECTION E-F.

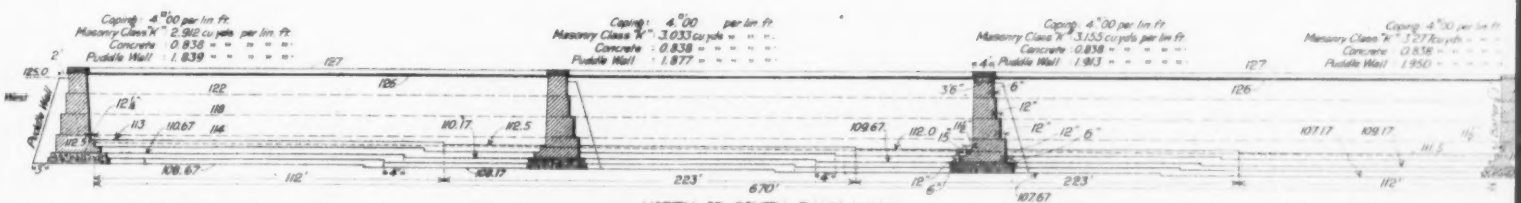
FILLING CHAMBER.



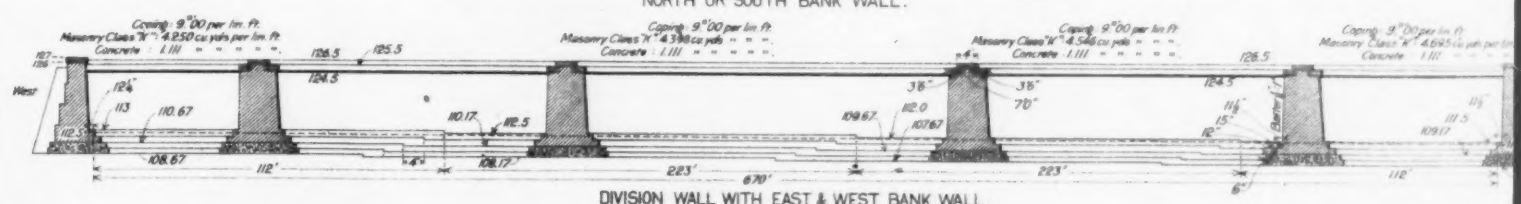
SECTION THRO' PAVED SLOPE NEAR WEST WALL.

SECTION THRO' CENTER LINE OF BASIN, LOOKING WEST.

BASIN BOTTOM SYSTEM.



NORTH OR SOUTH BANK WALL.



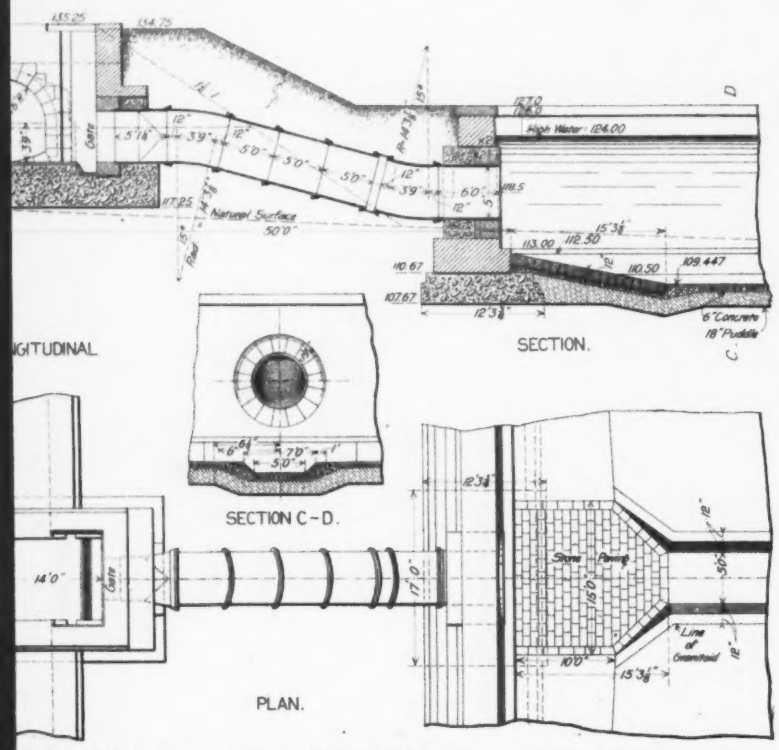
DIVISION WALL WITH EAST & WEST BANK WALL.

BASIN WALLS.

SETTLING BASINS OF ST. LOUIS, (MO.) WATER-WORKS LOW SERVICE EXTENSION.

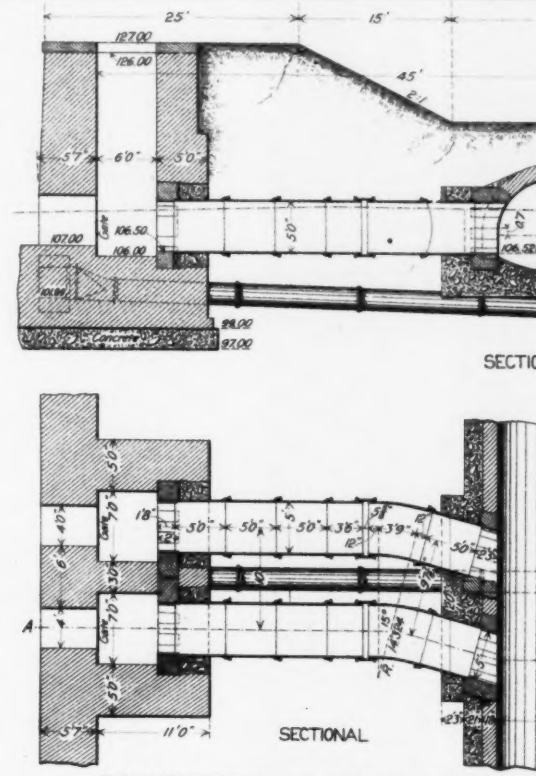
M. L. HOLMAN, WATER COMMISSIONER.

NOTE:—THE GENERAL PLAN OF THE WORKS IS PRINTED ON ANOTHER PAGE IN THIS ISSUE.



GITUDINAL

NECTION OF FILLING CHAMBER WITH SETTLING BASINS.



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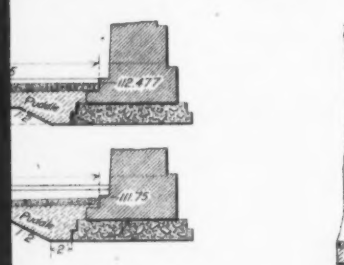

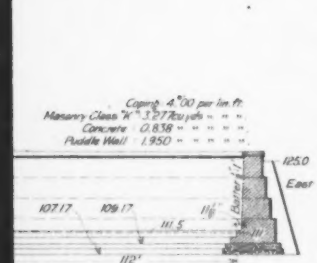
Coping 4.00 per lin. ft.
Masonry Class "A" 3.27 cu yds per lin. ft.
Concrete 0.838 " " " "
Puddle Wall 1.950 " " " "
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Coping 9.00 per lin. ft.
Masonry Class "A" 4.645 cu yds per lin. ft.
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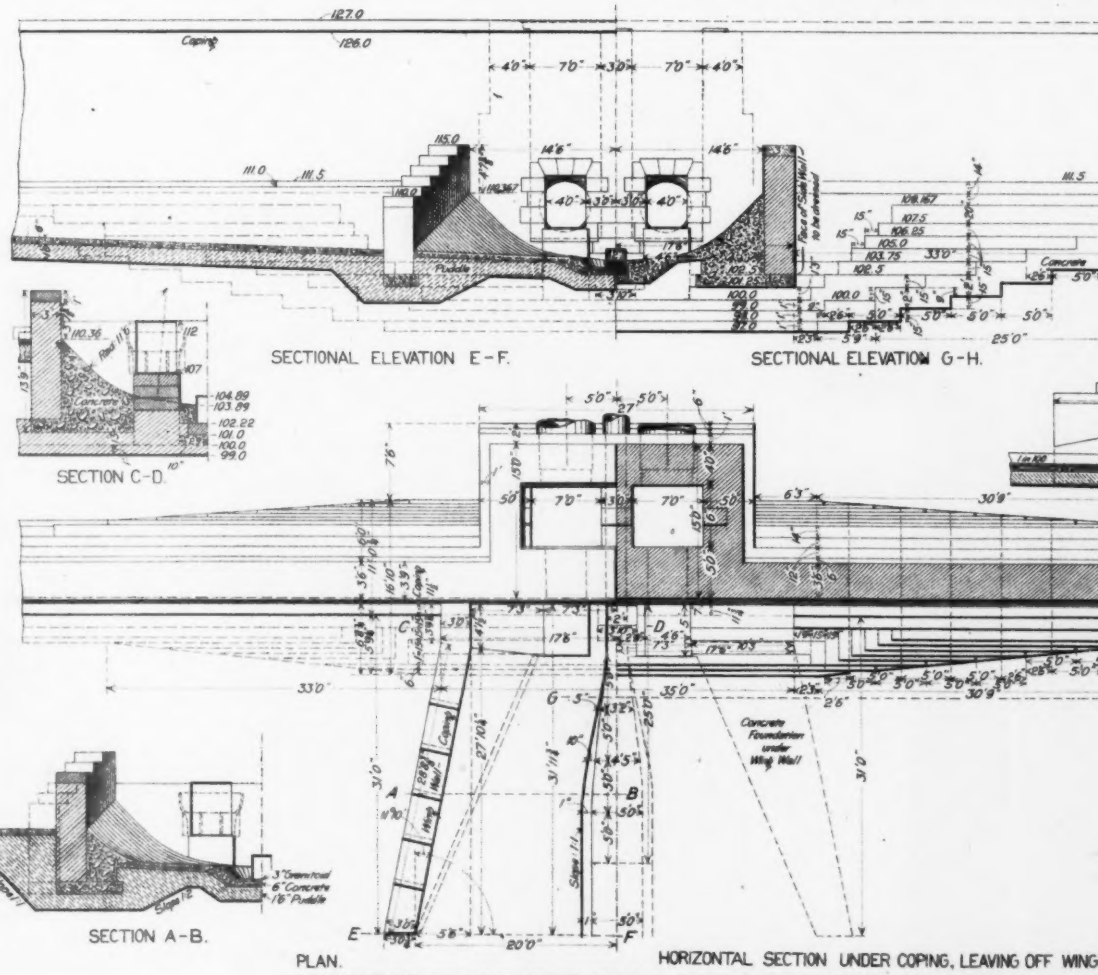
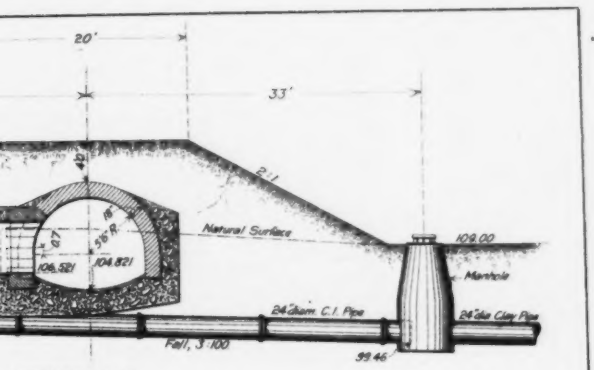
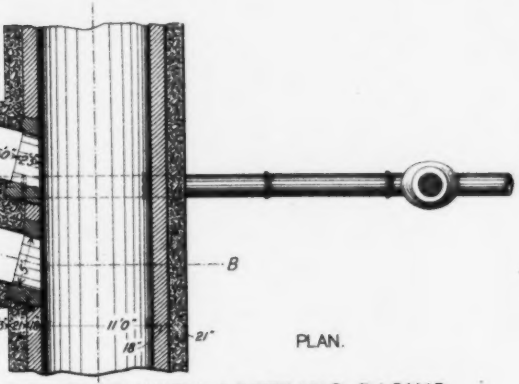
E EXTENSION.



CONNECTION OF SIDE WALL WITH DRAWING CHAMBER AND

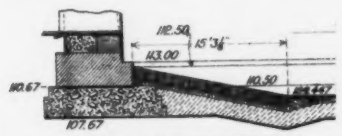


SECTION A-B.

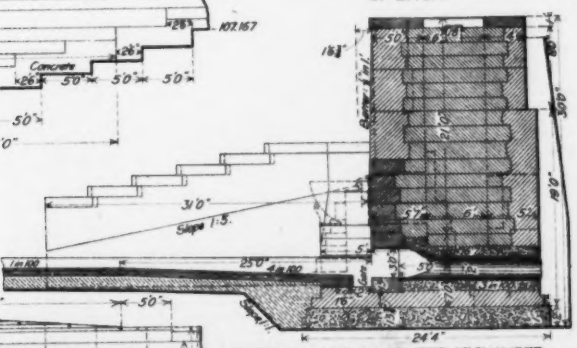


PLAN.

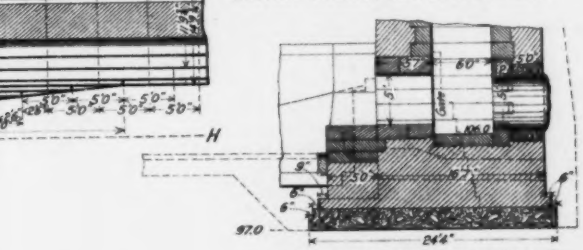
CONDUIT WITH SETTLING BASINS.



SECTION ALONG CENTER LINE OF DITCH.



SECTION THROUGH CENTER OF CHAMBER.



SECTION THROUGH CENTER OF GATE.

NG OFF WING WALL.

ER AND WING WALLS.

CHAS. HART & SONS, LITH., 99 VESEY ST., N.Y.

steel plate heated on one side, and kept cool on the other, was distorted more than a copper plate under the same conditions, the result being due to the superior conductivity of the copper.

The fact seems to have been overlooked that this experiment does not conform to the conditions of ordinary practice, in that the surfaces of the plates were clean. Mr. YARROW should repeat the experiment with the plates covered with a thin scale, as in ordinary practice, and see how much difference he finds in distortion and conductivity.

It is curious to note how quickly the author's arguments and experiments on this topic are seized upon as a vindication of English practice in the use of copper fireboxes. One individual writes to *The Engineer* to venture the sage guess that all the failures in marine boilers fitted with forced draft have probably been due to the use of steel fireboxes. A prominent locomotive superintendent (J. C. PARK, of the North London Ry.) writes to *Engineering*, detailing his failures with steel boxes and his success with copper. He gives the cost of material for a copper box in England as $417, the average life as 350,000 miles, the scrap value as $286, leaving $131 as the cost. The material for a steel box costs in England only $39. He has not been able to get any fair length of service out of steel boxes, however, and thinks that, "however successful the Americans say they are with their steel, we cannot reasonably give up copper."

Now American engineers are quite willing to concede that good service can be secured from copper fireboxes. They are not used here, simply because we have been able to make and use steel fireboxes, which give much better service for their cost than copper, and have proved in all classes of service to be safe, reliable and durable. In this, as in many other details of engineering practice, Americans have been successful in substituting a cheaper material for a more expensive, thus reaching the same results at less cost; and this constitutes a real advance in engineering practice.

TAKING the figures above given, a copper firebox costs in England over 11 times as much as a steel firebox. If we deduct the value of the copper for scrap, and let the greater interest on first cost of the copper box offset possible greater cost of repairs of the steel box, the copper box costs nearly 4 times as much as the steel box. Concerning the relative life, the average of 350,000 miles, given above, is the best we have ever seen for copper boxes; but we have little doubt that equally good records for steel boxes can be shown on roads in this country which have fairly good feed water.

Mr. YARROW stated in the paper that he believed American locomotives gave more trouble from leaky tubes than English. Where he secured the data for this opinion he did not state. We are not aware that leaky tubes give any special trouble on American locomotives. The subject has never been discussed by the Master Mechanics' Association, and there are very few ailments of the locomotive of much importance which have not been brought before that body.

The first cost of copper fireboxes for marine service is estimated by Mr. YARROW at from two per cent. to four per cent. of the value of the completed vessel. If the increasing demands of the electrical industries continue to raise the price of copper, the expense of copper fireboxes may be much more than this. On the whole, therefore, American engineers may congratulate themselves that they have been so successful in the use of steel for locomotive fireboxes. In time their brethren across the water may be able to do as well.

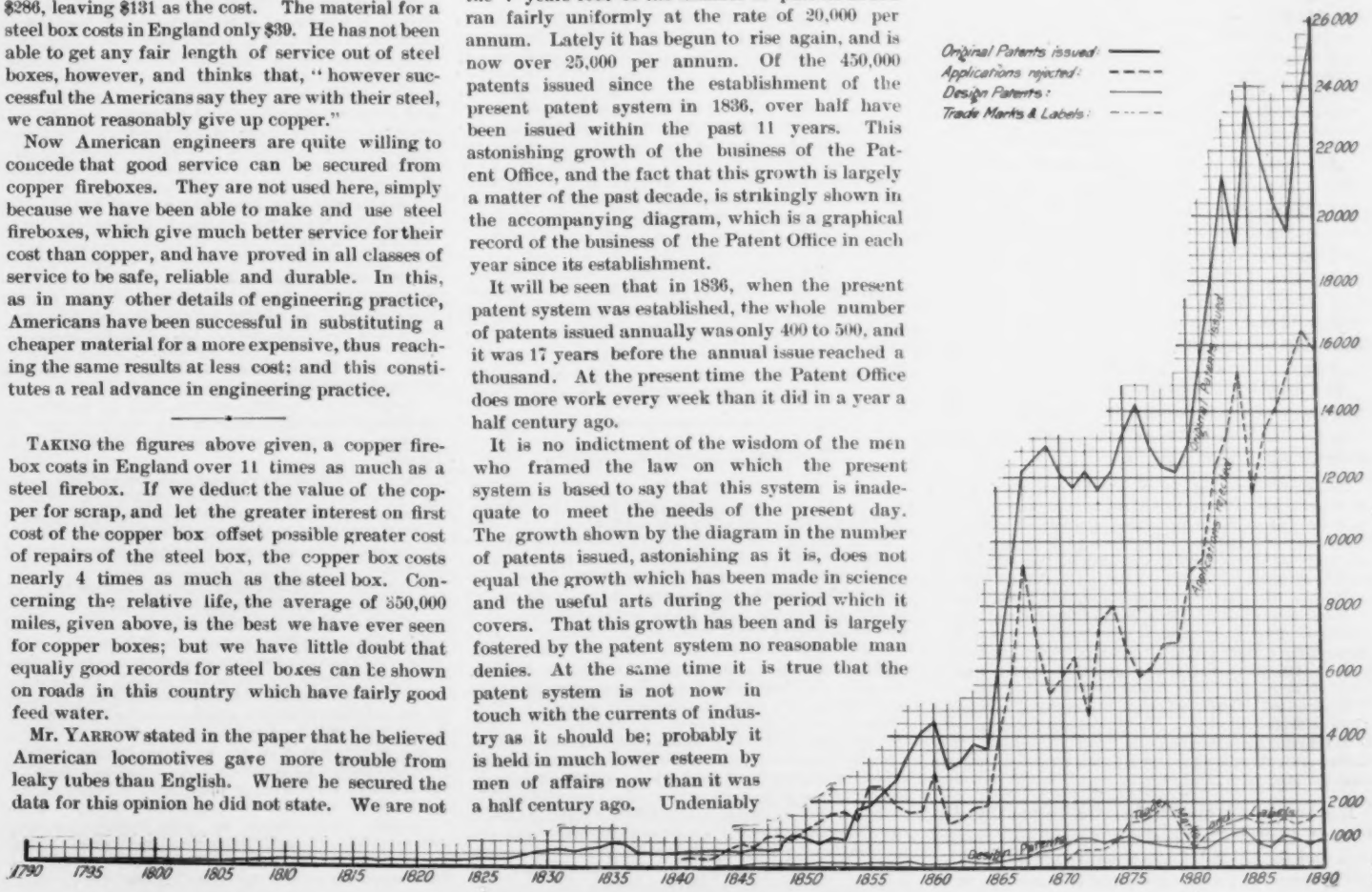
The American Patent System, Past and Present.

The anniversary of the establishment of the American patent system by act of Congress in 1790, which was appropriately celebrated at Washington last week, is a proper time for considering the present status of the patent system and the changes which it needs to better fulfill the purpose expressed in the title to the first American patent law, "To Promote the Progress of Science and the Useful Arts."

That changes are needed, practically all intelligent observers are agreed. The present patent law of the United States was passed July 4, 1836. The law passed in 1870, according to Justice ELATCHFORD, was substantially a re-enactment of the law of 1836. From the date of the first American patent, July 31, 1790, to the putting in force of the law of 1836, a period of 46 years, the total number of patents granted was 9,957, or an average of 216 per annum. From July 28, 1836, to the end of 1881, a period of 45 years, 251,685 patents were granted, or an average of 5,593 per annum. For the 7 years 1882–88 the number of patents issued ran fairly uniformly at the rate of 20,000 per annum. Lately it has begun to rise again, and is now over 25,000 per annum. Of the 450,000 patents issued since the establishment of the present patent system in 1836, over half have been issued within the past 11 years. This astonishing growth of the business of the Patent Office, and the fact that this growth is largely a matter of the past decade, is strikingly shown in the accompanying diagram, which is a graphical record of the business of the Patent Office in each year since its establishment.

It will be seen that in 1836, when the present patent system was established, the whole number of patents issued annually was only 400 to 500, and it was 17 years before the annual issue reached a thousand. At the present time the Patent Office does more work every week than it did in a year a half century ago.

It is no indictment of the wisdom of the men who framed the law on which the present system is based to say that this system is inadequate to meet the needs of the present day. The growth shown by the diagram in the number of patents issued, astonishing as it is, does not equal the growth which has been made in science and the useful arts during the period which it covers. That this growth has been and is largely fostered by the patent system no reasonable man denies. At the same time it is true that the patent system is not now in touch with the currents of industry as it should be; probably it is held in much lower esteem by men of affairs now than it was a half century ago. Undeniably it has been made, in some cases, to block the wheels of progress instead of urging them forward.



A CENTURY OF GROWTH OF THE AMERICAN PATENT SYSTEM.

These are things which should be remedied. The question which needs discussion and investigation is: How to do it? One proposed change is to abolish the system of examining into the novelty of an invention before granting a patent, and adopt instead the English system (which was also in force in this country from 1793 to 1836) of granting a patent without regard to the novelty of the device, leaving the inventors of similar devices to fight out in the courts the question of priority of invention. A change of this sort would be a bonanza to patent attorneys of a certain class, since it would place in their hands work which is now done by the Government at a small expense to the inventor. The Patent Office would then be merely a bureau for the registry of numberless rival claims, which would have to be fought over in court to prove their validity.

But the purpose of the patent system is to foster industrial progress by granting exclusive rights to first inventors. It is for the interest of both the public and the inventors that the identity of the first inventor and the validity and extent of his claims should be determined as quickly and cheaply as possible. To issue a patent for an old device deludes the inventor with false hopes, leads him to spend money needlessly, and lays another profitless task on the United States courts, whose dockets are now so overcrowded that the delays amount in many cases to a denial of justice. It seems too obvious to need proof that the search to determine the novelty of an invention can be made by the Patent Office far more quickly, certainly and cheaply than by the slow and expensive processes of the court room, or even by the office of the best equipped patent lawyer.

From a little book just published by Mr. LEVIN H. CAMPBELL, an assistant examiner of the Patent Office, we learn that in 1790, when a petition for a patent was presented, "Mr. JEFFERSON, who was Secretary of State, would send for Mr. KNOX, Secretary of War, and Mr. RANDOLPH, Attorney General, and the three distinguished officials would inquire with grave deliberation into the utility and importance of the invention." In 1891 the Patent Office has to cope with a stream of over 40,000 applications for patents per annum pouring in for examination. The law very properly requires that a patentable invention shall be "new," that is, it must not have been patented or described in any printed publication in this or any foreign county before the applicant's discovery. To determine whether this is the case or not, is the chief work of the patent office. The magnitude of this task, provided it were thoroughly done, may be realized by considering that the United States patents alone now exceed 450,000;

while nearly all civilized nations now have some form of patent system; and there are besides the countless scientific books and periodicals. When it is remembered, however, that these inventions cover all the wide range of industry, and are susceptible of endless classification and sub-classification, it becomes apparent that a fairly thorough search to determine the novelty of an invention is not impossible, provided thorough digests and classifications are at hand and sufficient time is available. Unfortunately, the searchers in the Patent Office have to do without these necessities. The actual state of affairs is very concisely stated in a recent article in *The Forum*, by Mr. PARK BENJAMIN. We quote from it as follows:

> It might be supposed that an inventor who should desire to determine for himself the novelty of an idea could here [at the Patent Office] find complete records for his assistance; or, inasmuch as to invest in a patent right without search into what has been done before, is like buying real property with no examination of title, that the intending investor might here have at his disposal, digested and abridged, all prior patents and publications which the almost unlimited facilities of the Government could secure for him. But no published abridgment or digest of the United States Patents is in existence. . . . There is an inadequate library, not properly indexed, and for purposes of research, but little better than the collection of patent records and scientific works in the Astor library of New York. . . . The examiners have no means of independently testing inventions; and such few digests as they possess, mainly of their own making, are in constant use and not accessible to the public.

As for the time available to consider each application, determine its novelty, and decide on the acceptance or rejection of each of its claims, there are now in the office 169 assistant examiners; and the number of applications for patents received per annum is about 43,000. Taking into account the numerous amendments, appeals, etc., which are made from the examiners' decisions, it is evident that not more than one day, on the average, can be given to each application.

The work of the examiners, in the scant time allotted to them, is seriously hampered by crowding and lack of conveniences. We quote again from Mr. BENJAMIN'S paper:

> The entire working force [numbering about 600] is crowded into about one-half of the available space in the so-called Patent Office building—the whole of which has been paid for out of the patent fees paid by inventors—the rest being occupied by the Interior Department, of which, for some inscrutable reason, the Patent Office is a bureau. The quarters are so inadequate that the most valuable records of the office lie piled upon floors and in corridors, despite the lesson of two disastrous fires. The average floor space given to each employee is about 7 ft. square, no allowance being made for passageways. Most of the occupied area is taken up by halls for the exhibition of old models, which are interesting chiefly to western bridal couples. . . . The present Commissioner calls the existing state of affairs "most deplorable." It is disgraceful; it not only impedes public business, but violates the plainest sanitary laws.

It is pretty well known that the Patent Office is a more than self-supporting institution. It has paid into the United States treasury nearly $4,000,000 in excess of its expenses; and this sum is now increased by over $200,000 every year. If this accumulated surplus were spent in providing the office with suitable quarters, and with proper libraries, and the digests so badly needed to carry on its work, and if all the receipts from patent fees were applied to an increase in the number, and an improvement of the quality of the working force, the approval of the Patent Office on an applicant's claim might be made to signify far more than it does to day.

Doubtless these improvements are not all the changes that are needed in the patent system; but they are the ones most apparent at present. If we can secure such efficiency in the Patent Office searches that the issue of a patent will be a moderately good guarantee of an invention's novelty, a great advance will have been made.

The subject is one in which engineers of every class are deeply interested. One not familiar with the Patent Office reports might be surprised to see how often the names of prominent engineers appear there. It is alike for the interest of the public and inventors that the faults and defects in the present patent system be remedied; and the principal engineering societies might possibly do a real service to the public and to the profession by appointing committees of men, specially qualified for the work, to investigate the needed changes and work together in bringing the subject to the attention of Congress. We have much more hope of reform starting from this quarter than from the National Association of Inventors and Manufacturers, organized at the patent celebration just closed. At any rate, the co-operation of the engineering societies with the new association would doubtless be a help in inducing Congress to take up the matter.

CORRESPONDENCE.

A Remarkable Rainfall:

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I notice in your journal of March 28, 1891, an account of a remarkable rainfall which occurred during the floods in Southern California and Arizona about the end of February. At the time of that storm I was in Redlands, Cal., and the man in charge of the celebrated Bear Valley Reservoir, in the San Bernardino Mountains, at which point are established a rain-gage and other meteorological apparatus, reported by telephone that, during the 24 hours from 6 P. M. on Feb. 21 to 6 P. M. on Feb. 22, 17 ins. of rain was recorded by the gage there, and 19 ins. in 26 hours. This is even a heavier precipitation than that reported by Mr. JAS. D. SCHUYLER, as recorded at the Cuyamaca Dam, in San Diego Co., and I believe greater than any previous recorded rainfall in this country.

H. M. WILSON, Geographer, U. S. Geol. Survey.

[The rainfall at the Cuyamaca Dam was reported as 23.40 ins. in 54 hours; of which 13 ins. fell in 23 hours and 7 ins. in 10 hours. The Bear Valley Reservoir is about 100 miles north by west from the Cuyamaca Reservoir, and in a region which ordinarily has somewhat more rainfall.—ED. ENG. NEWS.]

The Use of Traction Engines.

CLIMAX, Mich., April 7, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I note in your issue of April 4 an article on traction engines, in which you say that the use of these engines has received little attention in this country, except for farm work in some part of the west. I have no doubt as to the substantial truth of your statement, and yet I think the reader would be misled by it and not get any thing like a correct idea of the extent to which these engines are in use in this country. I think they are mainly used in the wheat-producing regions to furnish power for threshing machines. Nearly every township where wheat is a principal crop has one or more of them, which run the thresher, and haul them about from place to place. They have entirely supplanted the horse power for running threshing machines. When not in use for threshing they go about from place to place furnishing power for various purposes, such as sawing wood, running light sawmills, etc. Very little hauling is done by them, other than the water tanks or machines which they are used to run, as that is about all the hauling it will pay to use them for. There are several firms in Michigan which turn out traction engines by the hundreds yearly. At their first introduction there was much trouble from their frightening horses. That is mostly done away with now, as horses have become accustomed to them.

F. HODGMAN.

The "Common-Sense" Cattle-Guard—Explanatory.

GARDEN GROVE, Ia., March 31, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

SIR: I wish to call your attention to the name of our guard, which you describe in your issue of March 28. We sent you the name of the Common-Sense *Tile Surface Railroad* Cattle Guard. We are the father of the name of "Common-Sense," as that was our name used when we got it patented, Oct. 8, 1889. I see the Bush "Common-Sense" guard was patented July 15, 1890; so you will see we are the originators of the name; but we do not want it understood that we were using the name without a right to it.

KELLOGG, BAKER & STEARNS.

Engineering News from San Francisco.

SAN FRANCISCO, Cal., March 24, 1891.

TO THE EDITOR OF THE ENGINEERING NEWS:

SIR: The city of San Francisco is composed chiefly of one-story and two story wooden buildings; but since the erection of the three-story *Chronicle* Building, quite an impetus has been given to the construction of lofty blocks. The Crocker Building, on the corner of Market and Montgomery Sts., designed by BROWN, of New York, is already up several stories. It is being built with Phœnix columns, which carry the loads and are built into the masonry walls, and these are thoroughly tied together by the steel floor beams. It is expected that this will cause the building to vibrate as a whole and obviate any danger from earthquakes.

Two squares away, at the corner of Montgomery and Bush Sts., the iron work for the lower stories of the D. O. MILLS Building is in place. It was designed by BURNHAM & ROOT, of Chicago, and will be eleven stories in height, the largest building in the city. The construction is similar to the Crocker Building, except that Z-bar columns have been used. The Pacific Rolling Mills have the contract for the iron work.

The California Academy of Science, the gift of the late JAMES LICK, situated on Market St., has just been completed; the two lower stories are of granite and the upper five are of brownstone.

The San Francisco City Hall, the fame of which is widespread, is located on a triangular block, bounded by McAllister, City Hall Ave. and Larkin Sts. The front proper is the circular "Hall of Records," which reminds one of a mausoleum, with its arched porch, columned walls and dome roof. The main building is of 3 stories, and surrounds an open court; it is composed of several wings, of which the two on the north are not yet completed. It is built entirely of brick, on granite foundations. The brickwork is cemented over in imitation of stone, and presents a good effect from a distance.

Some of the façades have quite a grand and imposing effect, with the large composite columns and huge pilasters. On the southeast side there is to be a 550-ft. tower, of which only the first tier of enormous cast columns has been placed. In one of the unfinished north wings are the two 105-ton box girders, of which mention was made in your columns at the time of their shipment by the Keystone Bridge Co. They are bedded on granite blocks set in the brickwork, and at present carry only a light roof-work, although it is rumored they will support another story some time.

Altogether the entire structure will be among the handsomest municipal halls in this country, with its pleasing combination of dome, towers and pleasing façades.

The traveler in the West notes with interest the entire lack of system in most of the shops and factories. The introduction of some Eastern "red tape" would not be amiss. There is but little to interest one in the way of systems or appliances, but a short account of some visits may be of interest.

The Union Iron Works and the Pacific Rolling Mills are the two largest concerns engaged in iron work. They are situated in Potrero, a portion of South 'Frisco, 30 minutes' ride by a horse car from Market St. For some distance before reaching the works the road runs close to the bay, and a good view of the works can be had. In the foreground is the hydraulic dock, capable of lifting a 6,000-ton vessel, although it usually supports two of less tonnage. Nearer still may be seen the building ways, on one of which is the iron hull of the coast defense steamer *Monterey*, now nearing completion. It will be a modified monitor with a central superstructure. The larger smoke-stack will serve two cylindrical boilers, while a smaller stack back of this leads from the furnaces of a coil boiler for use when steam is needed in a hurry. The inner casing of the two turrets is in place, while the cellular compartments and lower deck are being riveted. It will be impossible to use port holes for lighting, and in lieu of these 170 circular glasses will be set in the upper deck.

Beyond this can be seen the ways for cruiser No. 2, which has not been named, but will be somewhat like the *Maine*. Her dimensions will be 380 ft. length, 64 ft. beam, 24 ft. draft and 8,511 tons displacement. She is expected to be one of the swiftest armored ships afloat, attaining a speed of at least 20 knots.

She will have great offensive power and will be heavily armored. The engines will be triple-expansion, driving twin screws.

Cruiser No. 6, for which the Union Iron Works have the contract, will be 330 ft. in length (15 ft. longer than the *Chicago*), 53 ft. beam and 5,500 tons displacement. Work is being pushed on her engines, but only a beginning has been made on the hull.

The company was organized in 1849, and at present employs about 1,800 men. All kinds of machinery are manufactured by the works; mining, milling, sugar making, engines, hoists, etc., and, in fact, they supply all classes of the machinery trade.

All the iron and steel shapes used on the cruisers are manufactured by the Pacific Rolling Mills, which are

situated just beyond the Union works. These mills have just been thoroughly remodeled at an expense of $500,000.

While at present the shapes rolled are few in number and not very heavy (in size they do not exceed 8-in. channels and 10½-in. beams), a greater variety will be rolled when the mills are reopened and beams as deep as 20 ins. will be made. In equal and unequal leg angles the list is now quite complete, 5 × 5 ins. and 5 × 3 ins. being the maximum.

The works cover about eight acres and employ about 1,000 men. The recent improvements include a new boiler plant located near the wharves. The coal is unloaded from the vessels directly into the bunkers overhead, and is fed to the boilers by gravity stokers. There are eight "double elephant" boilers of 2,000 HP. The new compound condensing, 1,200-HP. engine is arranged to take live steam in both cylinders when desired. The housings for the new rolls are just being placed. There are four trains of rolls in the mill, all served by furnaces burning producer gas.

Beyond these are two open-hearth steel furnaces, one old one, of about 17 tons capacity, and a new 20 ton furnace, which has not yet made a heat. The furnaces are served by hydraulic cranes. Some very large steel castings are turned out; one for the *Monterey*, a gun carriage ring, weighed eight tons. In the forge shop are 3 steam hammers, the largest being a six-ton one, built in 1883 at Leeds, England; some very heavy work is done on crank shaft forgings and the like.

Connected with the company, but having separate buildings, are the California Horse Shoe Co. and spike, rivet, bolt and nut works.

Vessels are lying at the wharves all the time, discharging Australian and Japanese coal, English scrap, coke, pig iron and some steel billets, the latter brought around the Cape. When the Nicaragua Canal is completed, all such traffic can come direct and freights will be much lessened. In addition it is hoped that there will be large shipments of raw material from the Eastern and Southern States.

C. E. FOWLER.

Calculating Overhaul for Earthwork.

PIER A, NEW YORK, March 17, 1891.

TO THE EDITOR OF ENGINEERING NEWS:

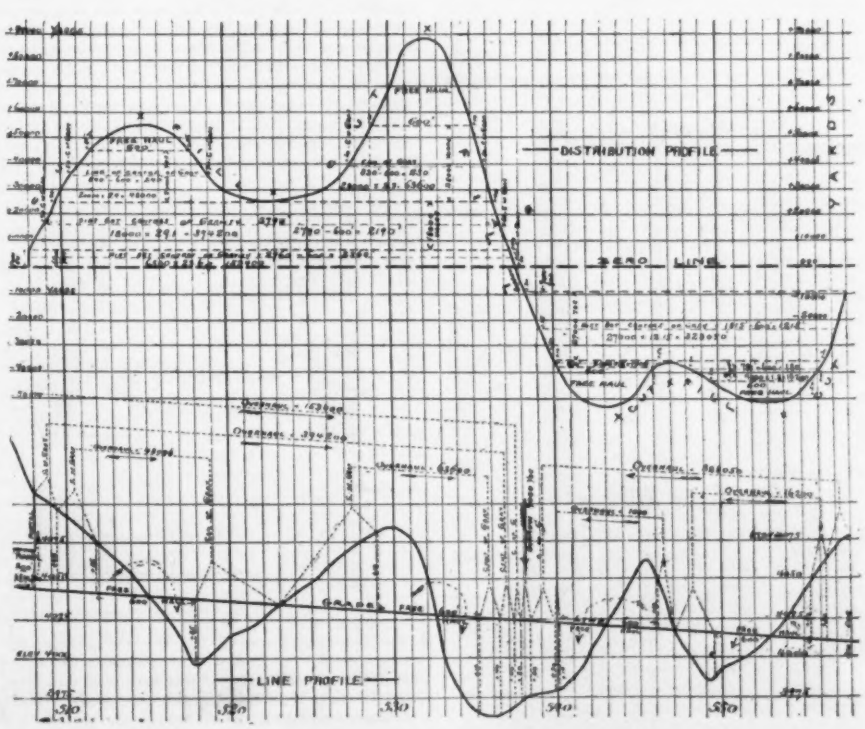
SIR: In your issue of Jan. 31, 1891, was published an example showing a graphic method of calculating overhaul in earthwork, by Mr. S. B. FISHER. He describes the economic distribution will often necessitate the hauling or overhauling of one cut through, or around another into the same fill rather than waste the far cut and borrow. I therefore submit the following example and diagram, showing a heavy section in railway work taken from actual practice, where the question of haul is rather more than ordinarily complicated.

NOTES OF QUANTITIES.

Station.	Cut. +	Fill. −	Algebr'ic summation.	Station.	Cut. +	Fill. −	Algebr'ic summation.
	From tunnel.				From tunnel.		
508	6,500	.....	+6,500	534	.....	17,500	+74,700
509	14,500	.....	+21,000	535	.....	19,600	+55,100
510	10,500	.....	+31,500	536	.....	23,400	+32,100
511	7,800	.....	+39,300	537	.....	19,600	+12,500
512	6,800	.....	+46,100	538	.....	18,300	− 5,800
513	4,500	.....	+50,600	539	.....	16,400	−22,200
514	2,800	.....	+53,400	540	.....	14,000	−36,200
515	600	.....	+54,000	541	.....	10,906	−47,100
516	.....	400	+53,600	542	.....	4,700	−51,800
517	.....	2,700	+50,900	543	.....	1,000	−52,800
518	.....	7,300	+43,600	544	800	.....	−52,0 0
519	.....	9,000	+34,600	545	5,400	.....	−46,600
520	.....	4,700	+29,900	546	8,600	.....	−38,000
521	.....	3,000	+26,900	547	1,800	.....	−36,200
522	.....	1,200	+25,700	548	.....	800	−37,000
523	.....	400	+25 300	549	.....	3,800	−40.80
524	200	.....	+25,500	550	.....	5,500	−46 300
525	1,500	.....	+27.000	551	.....	3,200	−49,500
526	2,800	.....	+29,800	552	.....	1,600	−51,100
527	5.900	.....	+35,700	553	.....	300	−51,400
528	7,900	.....	+43,600	554	400	.....	−51,000
529	10,900	.....	+54.5 0	555	2,800	.....	−48,200
530	13,900	.....	+68 400	556	7,800	.....	−40,400
531	14,000	.....	+82,400	557	13,900	.....	− 26,500
532	6,800	.....	+89,200	558	17,500	.....	− 9,000
533	.....	1,000	+88,200				

The method of obtaining this distribution profile has been sufficiently described by Mr. FISHER, so I will only add a few notes to apply to this particular section. The profiles are each necessarily plotted to a very small scale, and each to the same horizontal scale, so as to show maximum and minimum points of flexure for beginning and ending of cuts and fills, center of gravity, limits of free haul, etc., transferring stations for same direct with the eye from one profile to the other. In practice, however, work of this magnitude would demand that the distribution profile be plotted on as large a scale as possible, and preferably on cross-section paper. To eliminate figures and make the case as simple as possible, the percentage for swelling and shrinkage of the several materials is omitted, also all other detail unnecessary for a description, a yard of material of any kind being supposed to make a yard in the fill for which it is intended. Limit of free haul fixed at 600 ft. The cut from Sta. 529 + 10 is hauled free, making fill to Sta. 535 + 10, 600 ft; the rest of the cut is overhauled to Sta. 536 + 40. The approach cut from Sta. 511 + 85 is hauled free to Sta. 517 + 85 in fill. The next part of the cut, to Sta. 509 + 40 is overhauled, making the nearest fill to Sta. 523; the rest of approach cut to portal at Sta. 508 is overhauled through the adja cent fill and cut into the big fill at Sta. 537 + 40. The tunnel excavation is overhauled in same way to fill at Sta. 537 + 80.

It will often happen in side-hill work, where all the grading is started at once, that a temporary track for material may be graded around an intervening cut while the same is being excavated, in order to save time and avoid wasting where the material will be needed in a fill beyond, as in this instance. C. W. STANIFORD.



EXAMPLE OF OVERHAUL COMPUTATION ON HEAVY WORK.

plotting of a profile of quantity obtained from the successive algebraic addition of the quantities in the cuts and fills at each station, and this, in the main, is the same system which I have used and found an improvement on the old method.

Since this issue mentioned, there have appeared several other methods and suggestions, but all the examples given (including Mr. FISHER'S) are illustrated in very light work, and the haul is limited to the local consideration only of the removal of the cut direct to the nearest fill. In heavy work of a mixed classification the most

The Work of a State Geological Survey.

The State Geologist of Missouri, Mr. ARTHUR WILSON, in a recently issued annual report, summarizes the scope of the work done by a state geological survey and explains the reasons for the topographical surveys usually made by the geological commission and forming the most important feature of work as far as engineers are concerned. There is a mistaken idea that the bulk of the appropriation is spent for the purposes of finding new minerals and fossils. This is in no sense included in the main object of such a survey, as will be seen from the following abstract of Mr. WILSON'S report.

Two classes of work are recognized in a thorough scientific, geological and mineralogical survey, viz. subject work and area work.

Subject work is devoted to an investigation of the general facts of distribution for the whole state concerning a special substance. Details as to distribution cannot be given in a report of such comprehensive nature, which must necessarily be somewhat generalized. But it should be exhaustive in the discussion of the properties of the substance, and as regards the origin of the material; of the nature and future of the industries which may be dependent upon it, such a report can be complete.

Subject work is almost a necessity to day. At the date of the early surveys it was possible for one man to be an authority on a number of geological subjects, but this is no longer possible. Hence the separate subjects are assigned to a number of specialists, and the reports thus obtained may usually be regarded as thoroughly scientific.

Area work, however, in distinction from subject work, is designed pre-eminently for the purpose of giving detailed local information, and is calculated to meet the demands for information concerning certain areas. In this work maps will generally constitute the most important part. In geological work, topography should precede geology. Hence we find that in nearly all geological surveys in which detailed stratigraphic work has been attempted, topographic maps have been constructed, where such were not already available. Dr. GEIKIE, Director General of the Geological Survey of Great Britain, says:

> A perfect geological map should represent, 1st, a full and accurate topography, with the form of the surface, and heights in contour lines, shading or otherwise; 2d, all geological deposits, from the most ancient to the most recent, with their boundary lines accurately traced and the relation of their distribution to the external form of the ground clearly depicted.

In this country topographic surveys have been prosecuted in connection with the geological surveys in Pennsylvania, New Hampshire, New Jersey, Virginia, Michigan, Wisconsin, Texas, Arkansas, California, and also in connection with the national work under KING, WHEELER and POWELL.

In the case of all bedded deposits, topography furnishes valuable information concerning the relative vertical positions of different beds, as well as concerning the depths of such beds beneath the surface. On a map without topography, the outcrop lines of the two beds, one above the other, would appear simply as two sinuous lines, and no information would be conveyed concerning the interval between these beds, nor as to their depth beneath the surface at any point. In a rough country, these facts are of great importance and very much affect the valce of any property.

The facts contained on the topographic and geologic map are not of two distinct kinds, and are not collected separately and independently in the case of this survey; in fact, the data for the topography would be almost entirely collected in prosecuting the detailed work for the stratigraphy, and the facts of the topography are of indispensible assistance in solving the geological problems, the results of which are presented in a final map. The outlines of the hills, their altitudes, the positions of the different beds on their slopes all have to be noted,

whether the topography is accurately plotted or not, in order that we may obtain sufficient facts for delineating details of stratigraphy and distribution; the plotting of the topography along with such notes is, in short, only a systematic method of recording a multitude of observed facts. These facts, when carefully plotted upon such a map, are presented in the best possible form for study and comparison, and it is only through such presentation that many important results can be deduced; thus the data for such a map must very often be collected, in a large part, whether such map is ultimately prepared for publication or not.

The cost of state and geological surveys varies greatly, as may be seen from the following table, which gives the expenses up to 1886. But it must be borne in mind that many of these states had only begun their surveys at that date.

COST OF GEOLOGICAL SURVEYS.

State.	Years.	Cost.	Cost per sq. mile.
Pennsylvania.....	1874-85	$1,042,040	$23.10
New York.....	1838-80	712,000	14.50
Ohio.....	1869-80	355 786	8.65
Illinois.....	1851-75	190 330	3.36
Missouri.....	1853-77	176,185	2.54
Wisconsin.....	1873-79	149,000	2.66
Michigan.....	1871-75	132,000	2.24
New Hampshire....	1869-78	59,839	6.43

The annual appropriations made by several states for geological work, printing not included, are as follows: California, $100,000; Texas, $35,000; Arkansas, $18,000; New Jersey, $8,000. It is often possible to arrange with the United States surveys, geodetic or geological, so that only a portion of the total expense is borne by the states. In any case it is certainly a profitable expenditure of money, and the increased knowledge of the natural resources thus gained will tend to attract capital to undeveloped localities.

The Prevention of Leakage Around the Tubes in Boilers Using Forced Draft.

(*Concluded from page* 355.)

ELASTICITY OF TUBE IN THE TUBEPLATE.

What takes place in expanding a tube into a tubeplate? The tube is increased in diameter and pressed against the sides of the hole in the plate, the pressure slightly enlarging the hole. If the tube were free, it would expand and the hole in which it is would contract. To prove this, three 2½-in. tubes were expanded into a plate. Half the plate around the tubes was then cut away and the tube was removed. The following were the outside diameters of the tubes and the inside diameters of the holes in the plates after the tubes were removed :

	Diam. of tube.	Diam. of plate.	Difference.
Steel tube 14 B. W. G. in ¾-in. steel plate, ins.....	$2\frac{1}{8} + \frac{33}{1000}$	$2\frac{1}{8} + \frac{17}{1000}$	$\frac{7}{1000}$
Steel tube 13 B. W. G. in ⅛-in. steel plate, ins.....	$2\frac{1}{8} + \frac{19}{1000}$	$2\frac{1}{8} + \frac{5}{1000}$	$\frac{5}{1000}$
Copper tube 13 B. W. G. in ⅛-in. copper plate, ins.....	$2\frac{1}{8} + \frac{37}{1000}$	$2\frac{1}{8} + \frac{17}{1000}$	$\frac{10}{1000}$

From this it is evident that any sudden draft of cold air against the tubeplate from opening the firedoor or other cause will contract the thin tubes more rapidly than it will the thick tubeplate, and thus decrease the pressure between them. Another thing indicated is the desirability of having the tubes a tight fit in the plate before expanding, so that they will have to be driven in. Mr. PARK, of the North London Railway, attaches great importance to this.

EXPERIMENTS SHOWING THE ADVANTAGES OF THIN TUBE PLATES.

To ascertain what actually takes place with a thin tube and a thick plate, a tube 6⅞ ins. inside, made of ⅛-in. plate, was expanded into a 2-in. thick plate (see Fig. 10). Round the tubeplate thin sheet steel was fitted, forming a tank. This was placed over a forge fire for a few minutes, then removed and allowed to get cold, then replaced over the fire, and so on. After 8 repetitions of this, the tube began to leak, and after 18 times it leaked so much that the experiment had to stop. Fig. 10B shows the dimensions and shape of the tube at this time. What took place was that the thin tube got hot much faster than the thick plate, and, being prevented from expanding by the plate, the metal of the tube was permanently crushed.

The same experiment was then tried on a thick tube in a thin plate, as shown in Fig. 10C, and although heated and cooled 40 times no signs of leakage appeared. It is reasonable to infer from this that within certain limits the more nearly the tube and the plate approach each other in thickness, the more nearly will they contract and expand in harmony. Tubes cannot be thickened much, however, and retain the necessary elasticity; hence the tubeplates should be as thin as practical considerations admit.

Tendency of Tubeplates to Curve.—We will now consider perhaps the most interesting cause of leaky tubes. It is one which seems to have been completely overlooked by the marine engineer, though there is good reason to believe it is perhaps the chief source of trouble. With a view to its investigation we made a steel tubeplate 18 ins. long, 18 in. wide, ¾ in. thick. In it there are 36 tubes. Secured round the outside of this tubeplate are very thin sheet-steel sides, forming an open tank. (See Fig. 11.) This

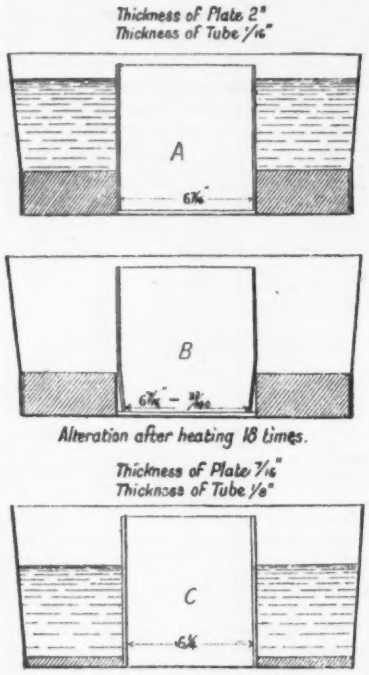


Fig. 10. Experiments Showing Effect of Varying Thickness of Tubes and Plates.

was filled with water and placed over the fire of a smith's forge. The bottom of the plate next the fire always being hotter, and therefore expanding more than the upper side, which was kept cool by the water, caused the plate to take a curved form. It was impossible to accurately determine the intensity of the fire, but those of us who were present feel sure that the heat was certainly not greater, but considerably less than in the furnace of a

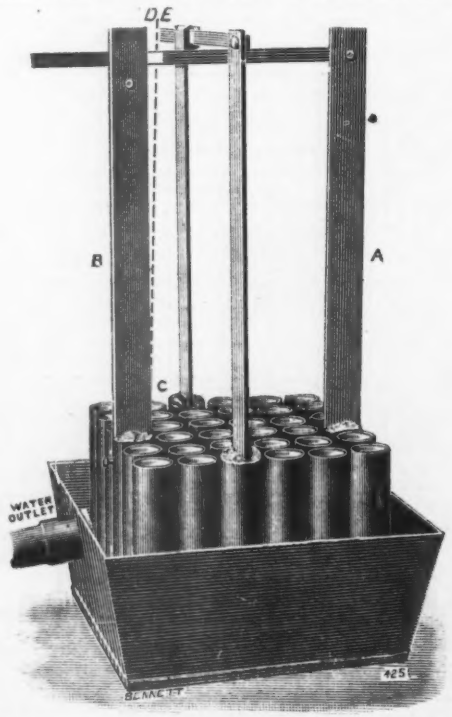


Fig. 11. Experiment to Show Curvature of Tubeplate when Heated.

marine boiler worked under forced draft. The extent of the curvature was indicated by the inclination of the uprights, as marked on the crossbars. The right-hand edge of the upright, *B*, moved from *C D* to *C E*.

If a curvature similar to this took place in the tubeplate of a first-class torpedo boat boiler, its center would bulge outward into the firebox 1⅜ ins. But in a boiler this plate is not free to move, and is forced to remain flat. Let us investigate what happens.

The surface of the plate nearest the fire tends to expand; the surface farthest from the fire wants to remain as it is, being kept cool by the water. The result is that these two portions of the plate are obliged to enter into a compromise, the effect of which is that the surface nearest the fire expands to the full extent due to the difference of temperature, except in so far as it may be prevented through its connection with the cooler surface, which it permanently stretches.

Now, when the boiler is cooled down, what happens? The surface next the fire wants to contract, but that in contact with the water, not altering its temperature, does not want to contract. The two surfaces, therefore, enter into a fresh compromise; the result of all these compromises being, if the plate is thick and the variations of temperature are great, that a permanent distortion of the plate takes place through this differential expansion and contraction. The holes are drawn out oval, some in one direction and some in another. When we consider that every time the fire door is opened and closed, the plate wants to change its form, and cannot do so, and when we bear in mind that the fire door in a large forced

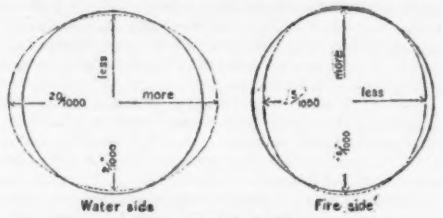


Fig. 12. Distortion of Hole in Plate by Heating.

draught boiler is frequently opened and shut, say once in every minute, which in 24 hours corresponds to 1,440 times it is easy to understand that the varying expansions and contractions set up severe molecular strains, and that the tube-plate is undergoing very harsh treatment.

Distortion of Hole in Plate Repeatedly Heated on Bottom Side.—We have here a plate which was kept flat, being allowed to move only longitudinally. It was heated and cooled on the lower side, water being on the upper. It thus approached the condition under which the plate would be in an ordinary boiler. The plate was 1⅛ ins. thick, and it had a hole very accurately bored in it 3⅞ ins. in diameter. It was placed over a forge arranged in such a way that a blast of hot and cold air alternately could be made to strike the plate on its bottom surface as often as required. After fifty times heating and cooling, the hole became distorted, as shown in Fig. 12, the hole at the upper surface, or water side of the plate, being longitudinally extended .020 in., and contracted transversely .002 in., the hole at the bottom surface of the plate next the fire being much less altered, as shown. The back lines on the diagram indicate the original hole, and the

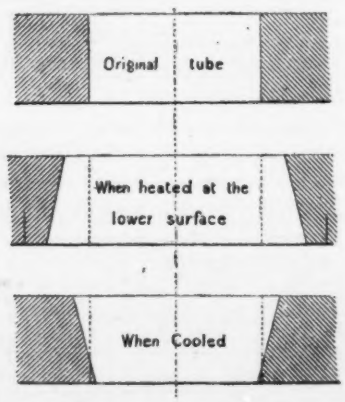


Fig. 13. Sectional View of Hole Distorted by Heating.

dotted lines the distorted hole. That the change may be clearly seen, the alteration is considerably exaggerated. Fig. 13 illustrates in another way this change of form.

To withstand repeated strengthening and bending without damage we all agree that the thinner and more flexible a plate is the better, as the reduced stretching due to alteration of form is then not so likely to exceed the elastic limit of the material and produce permanent distortion. It is sound reasoning to conclude that a thin and flexible plate has, for the same reason, an advantage over a thicker one, when heated on one side and not allowed to take up the altered form which it desires.

I think we may conclude that so long as marine engineers use thick steel tube plates they must expect trouble from leaky tubes. Probably for the same reason all flat surfaces exposed to the intense combustion of a forced draught furnace should be thin, if of steel.

I would venture to say that any greater thickness in a steel or iron tube-plate than ⅛ in. will probably lead to trouble; ¼ in. or more will certainly give trouble and be

always unreliable when worked in combination with forced draught. I would go a step further and say that whoever is bold enough to adopt ⅝ in. tube-plate will, I believe, not regret it. There is no good practical reason of which I am aware why a tube-plate should not be made in accordance with this. As regards the width of the joint between the tube and the plate, we, as engineers, know perfectly well that in making a steam joint a narrow surface and a good one, say ⅜ in. wide, is all that is necessary. As far as strength is concerned, I believe it is correct to state that no part of a boiler is so well supported and so strong, stayed as it is by all the tubes, as the tube-plate itself.

MISCELLANEOUS DETAILS.

Mr. WEBB has drawn my attention to a change in the nature of the steel in fireboxes subject to the influence of intense combustion. It appears the steel gradually absorbs carbon, and, therefore, alters its character, becoming more brittle. The effect on the tube plate and sides of the continual absorption of carbon makes them brittle after long usage and causes them to crack. This is well known to everybody who has had experience with steel in combination with forced draft.

Plastering Tube Plates.—We have heard of late much about plastering tube plates over with a non-conducting cement. This is an old and long since abandoned plan; none of us, I am sure, will consider it a practical solution of the problem. It is simply a temporary device and must be looked upon as worse than useless; because it gives a power of fictitious value, and when some of the cement

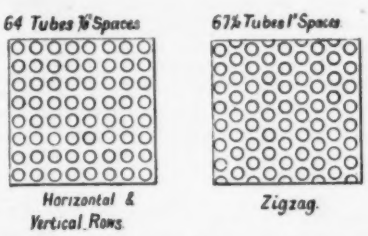


Fig. 14. Two Modes of Laying Out Tubes.

falls off, leaving part of the tube plate bare, the heat is concentrated upon that portion, and possibly worse strains are set up than if the entire plate were exposed. Boilers may, doubtless, be got through their trials by such means, or by exceptional skill and careful nursing by experienced stokers; but these must be considered as quite abnormal conditions. A boiler, to be thoroughly satisfactory, should undoubtedly be capable of management by men of moderate experience and such as, in case of emergency, would be available. It is obvious that a power which cannot be obtained on service without causing boilers to leak is a mere delusion.

Setting Out of Tube Plates.—Fig. 14 shows two systems: in one they are zigzag, and in the other in horizontal and vertical rows. The areas of the two plates are the same and the number of tubes is nearly so. It will be seen that with the zigzag setting out we get 1-in. spaces, while with the other we get only ⅞-in. spaces. From a "leaky tube" point of view I believe the former to be preferable. It will be seen that in the zigzag setting there are three directions of least sectional area of metal, while in the other case there are only two directions of least section; but the wounding of the plate at those two is greater than the wounding in the previous three. Bearing in mind the tendency of the plate to bend through being heated on one side, and that it is forced to remain flat, it follows that it is desirable to maintain as large a section of metal as possible, provided that section is not obtained by thickness. A corresponding example would be to take two bars of iron, into one make two nicks 1 in. deep and into the other three nicks ⅞ in. deep. All will agree that that the bar with three small nicks would be better able to withstand a transverse strain, and for this reason the zigzag setting out probably is the better. This is confirmed by the locomotive practice in this country and America.

Copper or Steel for Tube Plates.—Mr. YARROW discussed the relative advantages of copper and steel for tube plates, deciding in favor of the copper because a plate of a given thickness shows less distortion by heating than a steel plate. The coefficient of expansion of copper is to that of steel as 3 to 2, but the greater distortion which this would cause is more than counterbalanced by the superior conductivity of copper, which is to that of steel as 6 to 1. Consequently, he considered the relative distortion of copper and steel to be as 3 to 12. [In this point Mr. YARROW's conclusions seem open to criticism. When both surfaces are covered with even a thin coating of scale, which may be considered to be their ordinary working condition, the difference in conductivity of the two metals would probably be much reduced.—ED.]

Referring to locomotive practice, Mr. YARROW said he was fully convinced that Americans had more trouble from leaky tubes with their steel fireboxes than Englishmen had with their copper fireboxes. He referred to galvanic action in consequence of the contact of the two dissimilar metals, and said he had found that, if such action existed, it was of no practical importance.

Mr. YARROW concluded as follows: I hope the few observations which I have had the honor of making may, together with the discussion to follow, point to a means of dispersing the cloud which we must all admit hangs over our reputation as marine engineers so long as we are unable to design a boiler capable of conforming to natural laws. I trust the way may be seen to insure to war vessels the speeds for which they were originally designed, and that naval officers may look upon forced draught, not in the light they naturally do now, as an unreliable and dangerous device, but that they may consider it as one of the greatest improvements of modern times.

DISCUSSION.

Mr. DURSTON, Chief Engineer of the British Navy, could not agree with Mr. YARROW's conclusions. The beginning and end of all the trouble with forced draft was that certain portions of the boiler, notably the furnace tubeplates and the ends of the tubes, were overheated. This overheating he believed to be chiefly due to want of sufficient space between the tubes to permit free circulation of the water.

Mr. THORNEYCROFT advocated the water-tube boiler for forced draft. All the expedients suggested by Mr. YARROW and others would only postpone the day when the tube, expanded into a hole in a tubeplate exposed to the fierce action of the fire, must go. The joint between the tube and tubeplate forms a barrier to the passage of heat which cannot be passed without great difficulty. Experiment had proved that when a bar was cut in two, and the ends fitted to each other with great accuracy and even forced together under heavy pressure, the joint, although invisible, would ruin the heat conducting power of the bar. This would help to explain why tube ends in forced-draft boilers suffered so much.

Other speakers urged the merits of a water-table deflector, to give the flame a longer travel before reaching the tubeplate, and Mr. YARROW said it was an excellent thing if the tubes gave much trouble by leaking; otherwise it did no good.

Aeration of a Gravity Supply.*

During the past year I was called upon to advise in relation to the water supply of a small town, which supply was unique in several important particulars.

A dam about 20 ft. high had been thrown across the stream, and a large amount of water impounded in an artificial lake. The company purchased several hundred acres of surrounding land, tore down some 20 or 30 dwellings, and laid out the ground around the lake in a beautiful park. Everything in the nature of pollution along the banks of the stream emptying into the lake was carefully removed. The capacity of the lake is about 100,000,000 galls., and the daily draft therefrom about 200 000 galls., hence the capacity of the lake is 500 times the average daily draft. The quality of the water was generally quite satisfactory, but at times algæ in the water appeared with its usual accompaniment of an unpleasant taste and smell. As it was apparent that the difficulty arose from the unusual fact that the works had been built too large for the consumption, the first thing done was to waste the water into a miniature lake at the foot of the dam, and also through a large number of neat little fountains in different parts of the town. The water thus wasted was taken from the top, middle and bottom of the lake. This action afforded an immediate and very great relief, but it was only partially successful.

I then determined to resort to aëration, which personal experience during the last 7 years has caused me to regard with sincere respect. I believe that all waters are in their best condition when in motion. I believe that forcing air into water improves its condition, both by increasing the amount of oxygen in solution in the water and by keeping the water in motion. Under these conditions, water cannot stagnate, and different forms of bacteria and algæ, which are often so offensive, cannot exist. I believe that it is impracticable to physically remove this animal and vegetable life. Their existence indicates an unsatisfactory condition of the water, which should be cured, and, when the disease is cured, these friendly danger signals will disappear.

* A paper read by Mr. CHAS. B. BRUSH, Hoboken, N. J., before the American Water-Works Association.

The question therefore arose as to the best and most economical method of aërating this supply. As there was no steam power at hand I determined to make the water aërate itself. The water main from the reservoir to the town descends for a distance of about 400 ft., and then ascends for a distance of about 1,100 ft., passing over a summit through a large equalizing tank about 25 ft. in height, the flow line of which is on the same level as the reservoir. A 12-in pipe was laid from the gate-house at the lake down the valley for a distance of 350 ft. to within 50 feet of the lowest point of the main. Here was set up a 10-in. double discharge Leffel turbine wheel, connected with a small Clayton air compressor. The gates were arranged on the 10-in. turbine so as to make it equivalent to a 6⅝-in. wheel. The compressor was single-acting, 5 ins. in diameter and 6-in. stroke. When the water was turned on to the wheel the air was forced into the main by the compressor. This air forced its way against the water flowing through the main and rose toward the lake, coming up through the water in the gate-house in great volumes and agitating the water therein with considerable violence. The water thus aërated immediately lost its bad taste and smell, and the result was entirely satisfactory.

The head of the water on the turbine is 32½ ft., equivalent to 14.07 lbs. per sq. in. The air is forced into the main under a pressure of 20 lbs. per sq. in. It requires 3.15 cu. ft. of water to operate the wheel under the head of 14.07 lbs. in order to force 1 cu. ft. of air into the main against the pressure of 20 lbs. It requires 259,000 galls. of water per 24 hours to run the turbine so as to enable the compressor to force 82,250 galls. of air into the 200,000 galls. of water supplied from the lake to the town. But this 259,000 galls. of water thus used as power would have to be wasted in any event, so the motive power costs practically nothing. The horse-power from the water used is 1.23; the horse-power from work done is 0.67. Hence the efficiency of the plant is about 45%. The cost of operation is nominal—a little oil and a few minutes of the gate-keeper's time each day.

Inspection of Air Brakes for Freight Cars.

At the meeting of the New England Railway Club, on April 8, a paper on the above topic was read by Mr. ANGUS SINCLAIR. We abstract it as follows:

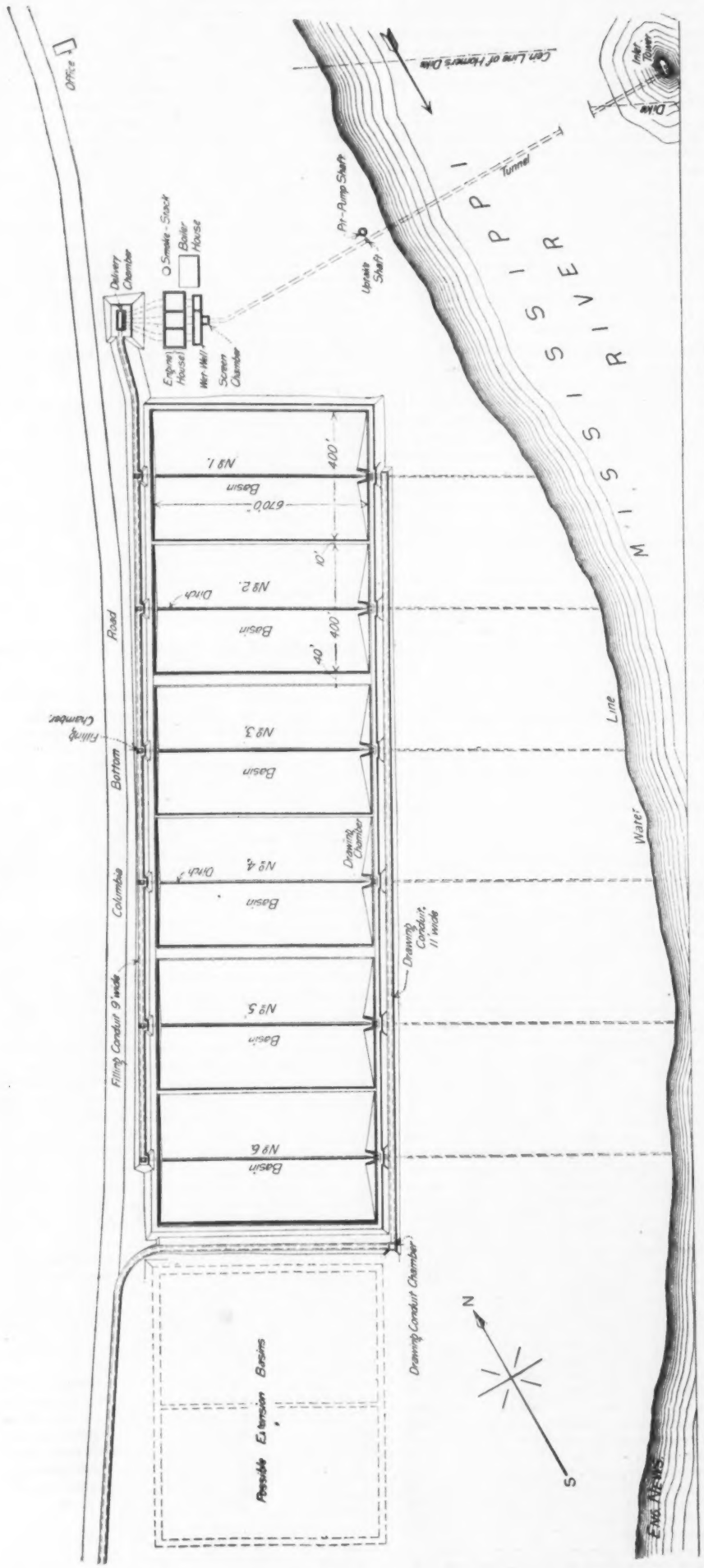
There are already in use over 160,000 freight cars equipped with air-brakes on the various railways of the United states. To secure the full benefit from these improved brakes, it is necessary that they should be maintained in good working order. This question of maintenance would be an easy one to settle if the cars never went away from home; but, as it is, it is time that provision was made to ensure as much care for air-brake cars on foreign lines as they receive at home.

In a few years it will be as rare a thing to see a freight car without an air brake as it now is to see a passenger car without it. Since the reform is inevitable, it is the duty of railroad officers to lose no time in preparation for it. The Rules of Interchange should provide for the rejection of an air-brake car with brakes in bad order. At present there is no provision for proper care and inspection of freight brakes in interchange, and many companies abuse the apparatus shamefully, neglecting to take up the slack and neglecting to keep the hose in the dummy coupling when not in use. The latter fault is the more serious, since it permits the entrance of dust and grit. This is generally due to mere carelessness; but it is none the less a serious injury to the owners of the cars. They have a right to demand that companies using their air-brake cars shall provide means for systematically testing them and keeping them in working order.

It is objected that roads not owning air-brake cars should not be required to examine and repair air-brake cars of other companies. On the other hand, it is plain that railways which fail to adopt a recognized improvement, like the air brake, are doing an injury to every enterprising road over which they send their cars.

The heads of car departments are generally of the opinion that in the near future air brakes must be inspected at all interchange points. Some think this an enormous undertaking. The Southern Pacific, however, all of whose cars have air brakes, has established a system of brake inspection and finds it no great task. The following is condensed from a letter from H. J. SMALL, Supt. of Motive Power:

At all division terminals we have plants for testing air brakes. These are usually located at the repair shops, and when repairs to cars are completed, air is applied at standard pressure and cars are turned out from the repair



GENERAL PLAN OF LOW SERVICE EXTENSION OF ST. LOUIS, MO., WATER-WORKS. Scale: 1 in. = 440 ft.

tracks with air brakes in first-class condition. Our switch engines are all equipped with air brakes; and, at interchange points, before cars are received from the connecting line, the inspectors have air applied to them by the switch engine. They are thus enabled to determine at once, before the car is received, whether there are any defects in the air brakes. Where switch engines are equipped with air brakes, it would seem to be unnecessary to have an air plant at interchange points where there are no car repair shops and only ordinary running repairs are made. Our conductors have cards on which they are required to report any defects they observe in the air brake during their run. This card is handed to the inspector immediately upon arrival at the terminal station. Concerning interchange rules for inspection of air brakes, I think that one rule would, perhaps, be sufficient—that is, that air brakes would not be received except in first-class order.

There is a mistaken impression that it is an expensive matter to keep air brakes in order, and that a machinist is required to take apart and repair the brake. The fact is, that any car repairer, with a day or two's drill, can do it as well. Inspiration will not take the place of this drill, however, and it is the duty of railway officers to see that their car repairers are properly trained in the care of air brakes.

In the discussion which followed the reading of the paper, much stress was laid on the proper maintenance of the brake. It was generally acknowledged that Mr. SINCLAIR was right in saying that the universal use of the air brake on freight cars was bound to come very soon. The instruction of trainmen in the management and use of the air brake was discussed, and it was voted to recommend to the railway companies centering in Boston that they unite in the purchase and equipment of an air-brake instruction-car for their joint use.

Settling Basins for the Low Service Extension of the St. Louis, Mo., Water-Works.

WITH INSET.

Work has been in progress for about two years on an extension of the St. Louis, Mo., water-works. The present supply is taken from the Mississippi River at Bissell's Point. The works for the additional supply are located at Chain of Rocks, about seven miles up the river. The general plan is shown in the accompanying engraving.

A tunnel 10 ft. in diameter has been driven beneath the bed of the river to a point about 1,500 ft. from the shore, where an inlet tower is located. The shore portion of the tunnel is about 800 ft. in length, and it ends at the pump-well. The pumps lift the water from the wet-well and discharge it into a delivery basin at an elevation of about 122 ft. above the river. As is pretty well known, the water of the Mississippi carries a large amount of sediment, and settling basins are provided to purify the water before delivery into the mains.

The location of these basins with reference to the supply and discharge conduits and the pumping station is shown on the general plan. The topography is not shown; but from the elevations on the inset sheet it appears that the basins are located on top of the bluffs, about 110 ft. above the river. After standing in the basins until the sediment is deposited, the water is drawn off into the delivery conduit and flows by gravity to the supply reservoirs at Bissell's Point, 7 miles distant, from which it is delivered into the mains.

Our inset sheet shows full details of the construction of the settling basins with the filling and delivering chambers and arrangements for draining and cleaning. It will be seen that the bottom of the chambers are covered with concrete, and the ditch along the center where scour is likely to occur is paved with granitoid on top of the concrete. An interesting detail is the casting at the mouth of the drawing chamber, which tends to prevent the exit of sediment carried along near the bottom of the chamber. The work seems to have been constructed in a very solid manner and with careful attention to details. The whole extension is in charge of Mr. U. L. HOLMAN, Water Commissioner, with Mr. S. BENT RUSSELL as Principal Assistant Engineer. The engineers in charge of the different portions of the work are: S. F. BURNETT, in charge of the tunneling; THOS. B. MCMATH, in charge of the conduit; and JAS. SELDON, in charge of the settling basins. We shall give further descriptions of the work in future issues.

Notes on English Railways.

(Continued from p. 342)

LONDON & SOUTHWESTERN RAILWAY.

This is one of the oldest and one of the principal southern systems, and has a total length of 880 miles. The original main line was from London to Southampton, but there is now a main line to Exeter and Plymouth, between which places and London there is a service of express trains in competition with the Great Western Ry. There are also branches running northwest from the main line to Bath, and to Burnham and Ilfracombe, the latter being watering places on the Bristol Channel. In the outlying districts to the southwest of London there is an intricate network of suburban lines with an enormous traffic. Among the principal places on this system, with distances from London, are the following: Windsor, Reading, Portsmouth, 74 miles; Southampton, 79 miles; Salisbury, 83½ miles; Bournemouth, 107 miles; Weymouth, 145 miles; Exeter, 171½ miles; Plymouth, 230 miles, and Ilfracombe, 225 miles.

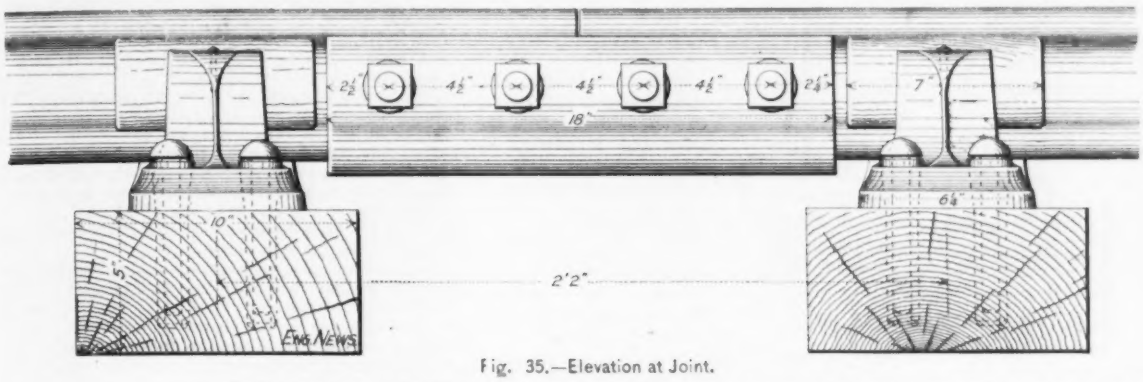


Fig. 35.—Elevation at Joint.

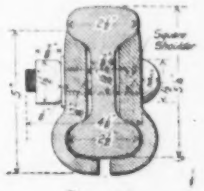


Fig. 37.
Cross Section at Joint.

ELEVATION AND CROSS SECTION OF TRACK; LONDON & SOUTHWESTERN RAILWAY, ENGLAND.

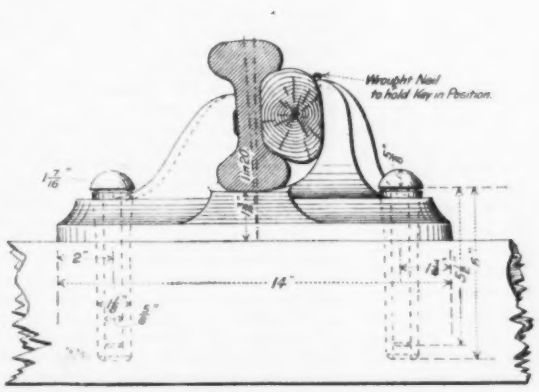


Fig. 36.—CROSS SECTION AT CHAIR.

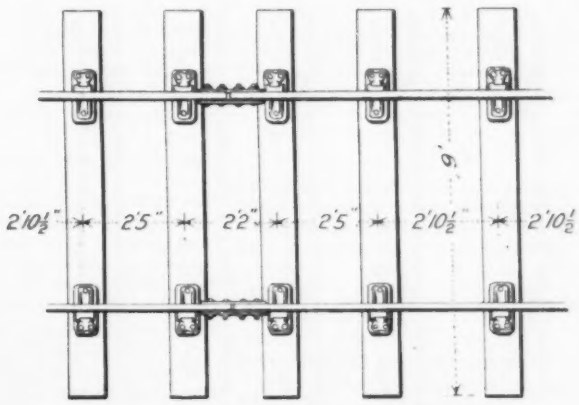


FIG. 38.—PLAN OF TRACK.

Track.—The standard type of track of English railways has already been described, and is here very clearly shown by the illustrations of the track of this line. This is one of the roads which adheres to the "double-head" section of rail, in which the two heads are of the same size and form, but the "bull-head" section, in which the lower head is the smaller, is the form of rail now most generally used. Fig. 35 is an elevation of the joint; Fig. 36, a cross-section at the chair; Fig. 37, a cross-section at the joint, showing the form of splice-bar generally used, and Fig. 38 is a general plan of the track. The rails weigh 82 lbs. per yd., and are laid with square suspended joints. The joint ties are spaced 2 ft. 2 ins. c. to c.; the next ties 2 ft. 5 ins., and the intermediate ties 2 ft. 10½ ins. c. to c. The bolt-holes in the rails are oval, ⅞ in. × 1⅛ in. Those in the inner and outer splice bars are ⅞ in. square and ⅞ diameter, respectively. In riding over the track the joints are very perceptible. An iron rail is driven vertically into each wooden key to prevent it from slacking back, a precaution which is very necessary, as on almost every road may be seen numerous keys that have worked nearly or quite out of the chairs. In some cases a nail is driven on each side of the jaw of the chair. On this road and on some others, shims or thin strips of wood, the depth of the web of the rail, are driven between the rail and key. This is apparently done where the keys have shrunk. The keys and trenails are of oak. The line running west of Exeter, through Crediton, has a double track of mixed gage (to accommodate broad-gage freight cars of the Great Western Ry.), laid with the double-head rails in chairs, the ties being about 10 ft. long. The joints of the three lines of rails are even. The standard gage rails have chairs and joints as shown in the illustrations; but the third rail has chairs with only one fastening on each side, and is spliced with plain splice-bars. The ballast is of broken stone or gravel. In the former case it is level with the tops of the ties, but in the latter case it covers the ties to the ends and has cross drains between every 3 ties or at the joints and middle of the rails. Longitudinal timbers are used on bridges. The ties are creosoted, but the oil seems to wash out, as in rainy weather the water draining from the track is streaked with oily, iridescent matter. Old ties are sawed into planks and are used in some places to line the sides of ditches in cuts. The signals are of the usual type, but the semaphore blades have a white and black disk (instead of square) on the red and white sides respectively. The Midland Ry. has adopted the same plan, but the disk is not so distinct as the square of contrasting color. Tall iron lattice signal posts are used to some extent. The switch rods are of gas pipe, with key or cotter couplings. The grade-boards are generally of wood, of the customary form shown in Fig. 39, but in some cases they are of iron, of the form shown in the same cut. The iron signs are painted black and have adjustable white enameled plates, with black letters, which are inclined in the direction of the grade. Iron signs on the same plan are used for ¼, ⅛ and ¾-mile distance posts. The ordinary distance posts are shown in Fig. 40; they are of wood, about 6 × 4 ins. and 10 × 4 ins. The lower part is painted black. Bumper block frames are frequently made of old rails bent to shape. The telegraph poles are creosoted, and are secured by wire or chain guys. The insulators are of brown earthenware, but on other lines the yellow glazed earthenware insulators are more generally used. The cross-bars are short, with generally one insulator at each end, and an insulator is placed on top of the pole, which has a metal cap to throw off the water. There are from 16 to 24 wires on the poles. Near London the poles are placed in pairs close together, with about 30 wires to each. At Exeter there are two stations, with steep grades rising to a summit between them. Bank or pusher engines, are used on these grades. In the neighborhood of London, and through the city, there is extensive work in progress for widening the line and laying new tracks. This involves the widening of brick viaducts and the rearrangement of tracks and switches in the face of a very heavy traffic, as in the case of the Great Eastern Ry., referred to on page 242.

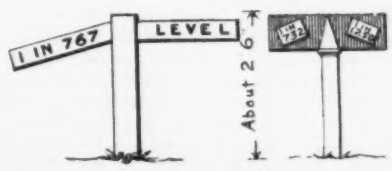


Fig. 39.—Grade Signs; London & Southwestern Railway, England.

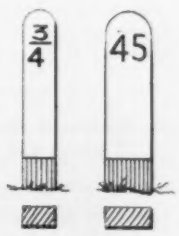


Fig. 40. Distance Posts.

Locomotives.—This road has a number of eight-wheel and tank engines with outside cylinders. A good specimen of the former, which embodies several features of American practice, was illustrated in ENGINEERING NEWS, Nov. 26, 1887. A larger engine of the same type is shown in Fig. 41. Among the most interesting engines on this road are some large and powerful tank engines, Fig. 42, with outside cylinders, four coupled wheels, a four-wheel leading truck and a single pair of trailing wheels under the rear tank and bunker. Some of the tank engines have

solid metal truck wheels. The leading dimensions of these engines are given in the following table:

	Eight-wheel. Fig. 41.	Tank. Fig. 42.
Cylinders	19 × 26 ins.	17½ × 24 ins.
Diam. driving wheels	7 ft. 1 in	5 ft. 7 ins.
Diam. truck and carrying wheels.	3 ft. 9¾ ins.	3 ft. 0 ins.
Diam. boiler	4 ft. 4 ins.	4 ft. 2 ins.
Tubes, number	240	.....
" diameter	1¾ ins.	.....
" length	11 ft. 4 ins.	.....
Heating surface, tubes, sq. ft.	1,245.60	.....
" " firebox, sq. ft.	122.16	.....
" " total, sq. ft.	1,367.76	1,056
Grate area, sq. ft.	18.00	.....
Driving wheel base	8 ft. 6 ins.	8 ft. 6 ins.
Total " "	22 ft. 9 ins.	29 ft. 5 ins.
Weight on truck, lbs.	40,768	.....
" on driving wheels, lbs.	35,056	.....
" on coupled wheels, lbs.	33,376	.....
" total, lbs.	109,200	129,920
Tank, U. S. galls.	3,960	1,200
Coal space, lbs.	.....	6,720

The engines are fitted with steam brakes on the driving and tender wheels, and with the automatic

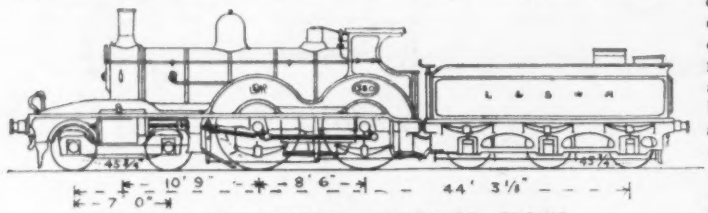


FIG. 41. EIGHT-WHEEL PASSENGER ENGINE.

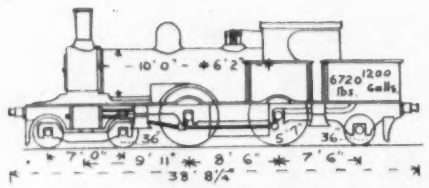


Fig. 42. Tank Engine.

vacuum train brake. Until a few years ago they were painted a dark brown, with black, green and orange striping. They are now, however, painted a dull green with black and white striping. The smokebox and smokestack are black.

Rolling Stock.—The equipment of this road, like that of most of the southern roads, includes a considerable proportion of old, small and uncomfortable cars with bare wooden seats, but there are many good modern-built cars of the ordinary type, on 2 or 3 rigid axles. Long cars on four-wheel trucks, with solid wheels, power brakes on every wheel, and lighted by compressed gas, are run on most of the express and long distance trains. Some of the first-class compartments seat only 6 passengers. The fittings of newer cars include spring handles to the doors, spring roller blinds to the windows, and blinds to the door sashes. The close-coupled cars of local trains have the buffer spring casings set back under the end sills, only the buffer rod and head projecting beyond the body of the car. The axle boxes make a great rattling when the train is running. The guard's vans have a portion of the roof raised, and fitted with side and end windows, so that the guard, sitting on an elevated seat, can see along the train. The automatic vacuum train brake is used. The cars are painted a dark sepia brown up to the window sills, and an ochre or orange tawny color above, with black and gilt striping and lettering.

The equipment includes 2 Pullman cars, which were put in service in May, 1890, between London and Bournemouth. The run is made in about 2½ hours, with few stops. The cars are run separately, each making one single trip or one round trip per day. The cars were built in the United States, shipped in sections, and put together at the railway company's shops in England. They are very similar to those in use on the London, Brighton & South Coast Ry. They are 62 ft. long over the buffers, 8 ft. 11 ins. wide over the eaves, 13 ft. high from the rail to the top of the roof, and are carried on four-wheel trucks. They were built as vestibule cars, but as they are not run together the ends of the vestibules have been built up. Heavy buffer beams, spring buffers, hook and screw link couplings, and the vertical ends of the brake pipe with its hose connection, are English features noticed at the ends. They are fitted with heaters, oil lamps, and electric bells. At one end are the smoking room, a very small lavatory, and the heater. At the other end are the ladies' room and lavatory, and the conductors' room. Each car has accommodation for 28 passengers, the saloon having 14 revolving chairs and a three-seat sofa at each end. The saloon has 9 large windows on each side, fitted with curtains and spring blinds, the interior arrangements being very similar to those of an ordinary American parlor car. One car is finished in English oak and upholstered in old gold plush; the other is finished in mahogany and upholstered in peacock blue plush. The smoking room end of the car has a large glazed sash in the end of the vestibule. The end of the vestibule at the conductor's end of the car, is fitted with a cupboard for crockery, glass and silverware, cutlery, cooking utensils and provisions. Light refreshments are well served, and the charges are very moderate. When running the smoking room vestibule is generally occupied by a social party on camp-stools, while the other end is blocked by folding shelves, culinary apparatus and passenger's baggage. There is an attendant to each car, who collects the car tickets and performs the duties of porter, waiter and cook. The railway tickets are examined and collected by the regular inspectors at the stations. These cars are only available for passengers with first class tickets, and an extra charge of 50 cents is made for the car ticket.

Stations.—The Waterloo terminus, in London, is one of the largest terminal stations in the world, and has a very heavy traffic of main line and suburban trains. The switch and signal systems are very complicated, and particulars of the train service and signal operations were given in ENGINEERING NEWS, Dec. 20, 1890. In one part of the station is a large train "annunciator," consisting of a large vertical frame fitted with a series of narrow horizontal slats arranged in vertical columns. Each slat has the name of a station on one side, the other side being blank. Above each column is a number representing one of the platforms. When a train is made up at any platform, the attendant at the annunciator fits notched brass templets into a chamber at the base of the column representing that platform, into which chamber are led the rods or wires working the slats. Then by turning a handle at the base of the frame, certain of the slats are turned, and indicate the stations at which the train will stop. Subways under the tracks are generally used to afford communication between the platforms. At stations with wooden buildings red fire buckets are hung up in a convenient position. The signal boxes are of frame construction. Monolithic concrete is quite extensively used for platform walls, wing walls and retaining walls. The names of the stations are displayed on enameled iron signs, having blue letters on a white ground. The more general custom is to have white letters on a deep blue ground. The freight yards at Vauxhall, London, are fitted with the electric light. Tall towers are used, with 2 arc lights on each. At some way-stations horses are used for switching cars. They are handsome animals of great size and power, and very heavily built. They are well treated and kept in excellent condition, and are very intelligent in their work. Most English railways employ numbers of horses for such work.

E. E. R. T.

(To be continued.)

An Enlarged Water-Way between the Great Lakes and the Atlantic Seaboard.

Mr. E. L. CORTHELL recently read a paper under the above head before the Canadian Society of Civil Engineers which was replete with interesting facts and figures bearing on its subject matter, from which we have prepared the following abstract. Mr. CORTHELL'S immediate interest in the problem arises from his studies for a "Hurontario Ship Railway" to connect Georgian Bay with Lake Ontario near Toronto, of which he is an earnest advocate, and his interest in which possibly leads him to do some injustice to the alternative possibilities; but into that question we will not enter, as he gives a great mass of facts of value and importance for weighing the merits of any such project. We condense the first part of the paper as follows:

The object of this paper is to discuss the question of the feasibility of making a water-way from the Great Lakes to the Atlantic capable of transporting the largest freight carriers now to be found upon the Great Lakes, weighing, with their cargoes, 5,000 net tons, with a draft of 20 ft. It would be a waste of time and of public thought to propose any project that is not fully abreast of the commercial times. Again, no narrow channel, even with a draft of 20 ft., is to be considered as at all adequate for the wants of commerce. Careful investigation has made it evident that nothing but unrestricted channels of the very largest dimensions for laden vessels of large tonnage will at all compare with the advantages of transportation by rail, particularly in the United States and Canada. As long ago as 1863 a National Ship Canal Convention was held at Chicago, and 5,000 delegates from all parts of the United States were in attendance. The special object of this convention was to advocate the enlargement of the canals between the Valley of the Mississippi and the Atlantic. In 1835 it was urged by an able advocate of water-way enlargement that the commerce of the Northwest had increased to so great a magnitude, that it had outgrown the Erie Canal and demanded a through route, not only to the Atlantic seaboard for its vessels, but to Liverpool.

Between the important ports on Lakes Michigan and Superior and Liverpool there are over 1,000 miles of water navigation, and only about 71 of them are restricted by natural obstacles in the channels. The object of this paper is to ascertain, if possible, how these natural obstacles placed here and there in the pathway of commerce may be removed, and steamships may be built on the Great Lakes to ply between their ports and the ports of the Atlantic seaboard and of the Old World.

Great and astonishing changes have taken place in comparatively recent geological times in the basins of the Great Lakes. There are well-defined high-water marks to indicate, at least, that the three great Northwestern lakes were probably 200 ft. higher than they are to-day; that there was a still greater lake, now Lake Winnipeg; that the immense overflow from all these lakes flowed southward to the Gulf of Mexico; and that great areas of country now inhabitated and cultivated by man were at that time submerged to a great depth.

The valleys of the Illinois River, the Minnesota River, and the Upper Mississippi as well, now occupied by comparatively small streams, prove conclusively that at a comparatively recent period there flowed southward great volumes of water, and that Lake Winnipeg drained southward, although now draining northward. A hypothesis was advanced, and an endeavor made to sustain it, by the late Gen. WARREN, to account for this remarkable change in the drainage of the continent. He attributed it to a great cyclic change in the continental slopes which depressed the northerly part of the continent and raised the southerly, as, for instance, the Florida Peninsula, as well as Cape Cod and other formerly submerged portions of the Atlantic Coast. This great southerly current of the vast interior basins of fresh water of the continent was hemmed in on the south by an ancient barrier, which evidently crossed the Mississippi near Grand Tower, Ill.; but the waters gradually cut their way through, and thus largely drained the great inland sea. Either by this means or by the changes in the continental slopes, the waters were drained from the land, and the conditions were slowly changed until we have the Great Lakes of to-day.

At Chicago is the lowest line cross section of the trough or *thalweg* through which the waters of the lakes flowed southward. The bottom of this trough is only about 8 ft. above the present level of Lake Michigan, with a natural drainage and a steep slope down the Illinois River Valley from the immediate suburbs of the city. At this location has been built within the last half century the second city of the continent, and at this point, connecting the lake with the tributaries of the Mississippi River, there was projected in 1670 a canal to the Illinois River. It was proposed by one of the earliest pioneers, JOLIET, to dig a canal across the Chicago Divide for commercial and military purposes. In 1804 ALBERT GALLATIN, Secretary of the Treasury, spoke of the national character of this proposed waterway. In the first comprehensive report on internal communication, DEWITT CLINTON and GOUVERNEUR MORRIS in 1808 to 1825 urged the "proposed ship canal" as an extension of the Erie Canal to the Mississippi, in order to open up water communication by the lakes from the Hudson River to the Gulf of Mexico. Congress assisted in the project, and made a land grant of 281,000 acres in 1827 for the construction of the work. The first canal was opened for navigation in 1848. In 1865 the State of Illinois provided for its completion; it was completed by the city of Chicago for drainage purposes in July, 1871, but the flow through it proved insufficient for the purpose, and in 1881 the State required the city to erect pumping machinery of a capacity of not less than 60,000 cu. ft. per minute, which was put into operation in 1884. The original canal was 6 ft. deep, 60 ft. wide, at surface, 36 ft.

wide at bottom in earth, and 46 ft. wide in rock, with locks 110 ft. long, 58 ft. lift., and 6 ft. on the miter sills.

THE NEW CHICAGO DRAINAGE PROJECT.

The rapid growth of the city requires a much more adequate drainage for its sewage than is now provided, to prevent the pollution of its only source of water supply and to carry the sewage away from the city as quickly as possible. A channel for drainage purposes as well as for navigation purposes has been authorized by the State Legislature. Nearly the entire area of the city has, under the State law, been organized into a drainage district. The law requires (and this requirement, it may be stated, was demanded by the towns and cities located along the Illinois River) a continuous flow of not less than 300,000 cu. ft. per minute, with a current not exceeding 3 miles an hour; and 600,000 cu. ft. per minute, when the population of the district draining into the channel exceeds 1,500,000, with a requirement for a still larger volume when the population exceeds the number last named. It is specified that the water shall not be less than 18 ft. deep through the channel, and that the width of the channel shall not be less than 160 ft. at the bottom. By a joint resolution the Legislature requests the United States Government "to aid in the construction of a channel not less than 160 ft. wide and 32 ft. deep, with such a grade as to give a velocity of 3 miles per hour from Lake Michigan at Chicago to Lake Joliet, a pool of the Des Plaines River immediately below Joliet, and to project a channel of similar capacity and not less than 14 ft. deep from Joliet to La Salle, all to be designed in such manner as to permit future development to a greater capacity." It is apparent from the rapid growth of the city, that long before these works, so great in magnitude, and costing probably $25,000,000 or $30,000,000, shall have been completed, there will be at least 2,000,000 of people in the drainage district. The normal growth of the city will, no doubt, make the population as great as this before the year 1909. The large quantity of water to be sent through this channel into the Illinois River Valley will, it is expected, raise the low water level of the Illinois River about 7 ft., and that of the Mississippi River at St. Louis at least 1 ft., and probably 6 ins. at Cairo at the junction with the Ohio River. On the Mississippi River itself the United States Government is expending large sums of money in deepening and rectifying the channel for navigation, with the ultimate purpose of obtaining a minimum depth of 10 ft. at low water between New Orleans and Cairo, a distance of about 1,000 miles by the course of the river. As is well known, it has expended a large amount of money in removing the obstructions at the mouth of the Mississippi, and has created by the works there a channel 30 ft. deep between the river and the Gulf of Mexico. This result was obtained in 1879, and the channel has increased rather than diminished in size since that day through the jettied channel. As incidentally of interest, it may be stated that the United States Government is about to connect the navigable waters of the Illinois River with those of the Mississippi River by a canal across the country from Hennepin, on the Illinois River, to Rock Island, on the Mississippi River. This is not to be a ship canal, but a boat and barge canal. There will be 37 locks, 170 × 30 ft., 7 ft. on miter sills. The height to be surmounted from Hennepin going westward to the summit in a distance of 20 miles is 208 ft. The difference in level between this summit and the Mississippi River at Rock Island is 102 ft.; the length of the canal will be 77 miles. The entire distance between Chicago, on Lake Michigan, and Rock Island, on the Mississippi River, by way of the Illinois River and the Illinois and Mississippi Canal, will be 193¼ miles. The plans are made for the work, and construction is expected to begin soon.

One question in relation to the proposed drainage and water-way channel between Chicago and the Mississippi River is, What effect, if any, will the abstraction of so large a volume of water from Lake Michigan have upon the level of that lake and of Lake Huron, and upon the volume flowing through the Detroit River into Lake Erie?

On Sept. 8, 1888, a paper by Mr. GEO. Y. WISNER, was read before the Western Society of Engineers, entitled: "Levels of the Lakes as Affected by the Proposed Lake Michigan and Mississippi Water-way." Mr. WISNER had had at that time about 20 years' experience on the rivers, harbors and lakes of the Northwest, and was connected with the Great Lakes survey. His opinion was that "Probably the low water level of the lake would never be affected to exceed 2¼ ins. by withdrawing 10,000 cu. ft. per second from Lake Michigan for the proposed water-way. The lowest stage occurs in winter, when navigation is closed." "The annual rise of the lake usually covers a period of about 4 months, and consequently the variation in the yearly fluctuation of the lake surface, due to withdrawing such a volume of water, could not exceed 1 in." "When we consider that hourly fluctuations of the lake surface of from 6 to 30 ins. in amplitude are constantly taking place, it is evident that the withdrawal annually of a volume of water from Lake Michigan, equivalent to 3 ins. in depth over the surfaces of the two lakes would not be appreciable in any ordinary set of gage readings, and would certainly have but little effect upon the depth of water in the connecting water-ways." Somewhat similar artificial conditions have been produced by the deepening of the St. Lawrence rapids below Ogdensburg from 10 to 16 ft. adding from 6 to 8½ to the free channel of the river. The question was considered at that time, and was referred to the United States Engineer Department, and the conclusion from the investigation was, that the effects would extend to no great distance, and that the level of Lake Ontario would not be impaired. The deepening at the Lime Kiln Crossing of the Detroit River, where the depth has increased from 13 to 20 ft., and at the St. Clair Flats, which have been deepened from 9½ to nearly 20 ft., are cases generally similar to what is practically the deepening of the channel now existing between Lake Michigan and the Illinois River, and yet no injurious results have been experienced or are they anticipated.

[The paper then rehearses the main dimensions and depths of the Great Lakes, which can be better seen by a glance at an illustrated paper in our issue of Oct. 6, 1888, and continues:]

From the city of Kingston, at the eastern end of Lake Ontario, to the ocean, the distance is 1,164 miles, although Cape Gaspé, which is considered the mouth of the St. Lawrence River, is 400 miles from the Ocean. The St. Lawrence between Ogdensburg and Montreal is obstructed by rapids at several places, which have been improved either by removing the obstructions in the natural channels or by flanking them with artificial canals. From Montreal to the Gulf of St. Lawrence a navigable depth for ocean vessels exists by nature, except at a few points where the channel has been improved by dredging to over 27 ft. and to ample width. The improvement in the St. Lawrence River from Lake Ontario to the Gulf of St. Lawrence has been made by and at the expense of the Canadian Government. The accompanying sketch map shows present and proposed routes.

ST. MARY'S FALLS CANAL.

(Commonly called the Sault Ste. Marie Canal.)

A canal 100 ft wide with a depth of 12 ft. was opened to commerce in 1855; the 2 locks were 220 ft. long and 70 ft wide. In 1882 nearly $2,500,000 had been expended on the canal and the prism enlarged to a width varying from 500 ft. at the upper entrance to 108 ft. at the narrowest part, and the depth from 12 ft. to 16 ft. at a mean stage. A new lock had been constructed 515 ft. long × 80 ft. wide, with 17 ft. of water on the miter sills. In 1886, Congress provided for a still larger lock, based upon 20 ft. depth through the canal, with a lock 800 ft. long × 100 ft. wide, with 21 ft. on the miter sills. The estimate for an enlargement of the canal and the construction of this lock is $4,738,865. This lock is now under construction.

ST. CLAIR RIVER IMPROVEMENTS.

A canal through what is called the St. Clair Flats was projected in 1866 for the purpose of obtaining a straight channel 13 ft. deep, 300 ft. wide and about 1¼ miles in length, each side being protected by timber dikes resting on piles, the cribs thus formed being filled with material dredged from the channel and backed by dredged material. In 1873 the channel was deepened to 16 ft. by dredging a width of 100 ft. on each side of the channel axis. The project now contemplates a double row of sheet piling to a depth of 26 ft. along the channel face of each of the old dykes, dredging the area between the dykes to a depth of 20 ft., and continuing the channel above and below the canal to the same depth in the river and in the lake. On this work there has been expended nearly $700,000.

The Lime Kiln Crossing at the mouth of the Detroit River is also being deepened to 20 ft. The depths demanded by and obtained for the increasing commerce through these channels have been as follows:

1858	9½ ft.	1871	12 ft.
1874	13 "	1885	16 "
1890	20 "		

WELLAND CANAL.

The first project was to build a canal and railroad combined in 1824, but the railroad feature was dropped and the work was begun with wooden locks 110 ft. long, 22 ft. wide, with 8 ft. of water on the miter sills. Water was let into the canal in 1829.

According to the decision of 1843, the locks were to be made 150 ft. long by 26½ ft. wide, with 9 ft. on the sills. The width of the straight parts of all the reaches was to be not less than 26 ft. This enlargement fully doubled in capacity both the prism and locks of the original design. In 1880 another enlargement more than trebled the size of 1843, the width being 100 ft. at the bottom. There were then 27 locks, each 270 ft. × 45 ft. The final enlargement was to locks of 270 ft. × 45 ft., with 14 ft. of water on the miter sills. The length of the canal is now 26¾ miles. There are 3 guard gates and 25 lift locks. The total rise, or lockage, is 326¾ ft. There has been expended on this canal up to 1889, $23,787,950.

TRENT RIVER NAVIGATION.

This navigation is a series of disconnected water stretches, extending from Trenton at the mouth of the Trent River, at the Bay of Quinté, Lake Ontario, to Lake Huron. It has never been used for anything except local traffic, as it has a depth of but 5 or 6 ft. Its entire length is about 201 miles. The beginning of the work dates back to 1837. The total lockage is 1,044 ft. The impracticability of transferring this circuitous route over an undulating country into a ship canal of adequate dimensions to carry the traffic of the Great Lakes to the seaboard is apparent without any argument.

THE ST. LAWRENCE IMPROVEMENTS.

The St. Lawrence canals are: Lachine (near Montreal), Beauharnois, Cornwall, Farran's Point, Rapide Plat and Galops, their combined length being 43¾ miles, viz.: Lachine 8½; Beauharnois, 11¼; Cornwall, 11½; Farran's Point, ¾; Rapide Plat, 4, and Galops, 7⅜ miles. In 1841 when the system of canals between Montreal and Lake Ontario was designed, it was intended to obtain a depth of 9 ft., but on account of fluctuations in the river itself the depth in the canal could not always be maintained. At times it fell in some of the canals to 6 ft. 7 in.

In 1871 it was decided to enlarge the canals on the St. Lawrence, to afford a navigable depth of 12 ft. throughout, and then again shortly afterwards it was decided that the ultimate depth should be sufficient to accommodate vessels of 14 ft. draft. Work has been carried on since that time with this object in view. The locks are to be 270 ft. long between the gates, 45 ft. wide, with a clear depth of 14 ft. on the sills. This work has not been entirely completed, but for the purposes of this paper and the estimates which will follow for a still larger water way, the work is assumed to be entirely performed. In round numbers it may be stated that the entire amount expended on the St. Lawrence system from Lake Erie to Montreal is about $41,250,000, and it may be estimated that it will require to obtain a depth everywhere in the river and in the canals of 14 ft. $12,750,000 more, or about $54,000,000 in all, not including the cost of the construction of the canal at the Sault Ste. Marie and other necessary improvements. Therefore, to obtain, between Lake Superior and Montreal, a full depth of 14 ft., will cost, all told, about $60,000,000.

ERIE AND OSWEGO CANALS.

While it is not probable, and perhaps not possible, that the Erie Canal can ever be made to perform a greater part in the development of the country than it has already performed, yet on account of its past usefulness it is necessary to briefly sketch its history. It extends from Buffalo on Lake Erie to Albany on the Hudson River, a distance of 350.5 miles, with 71 locks 7 ft. deep, 110 ft. long and 18 ft. wide. The total lockage is 481¼ ft. This was in 1835 [since which it has been greatly enlarged, figures for which are omitted.—ED.], and the total cost of the canal up to that time had been $38,977,830.

The Oswego branch of the Erie Canal leaving Lake Ontario at Oswego is 38 miles in length, and it descends 155 ft. from the Erie Canal to Lake Ontario, with 18 locks 110 ft. long by 18 ft. wide. The total cost in 1865 had been $3,077,429. Improvements and enlargements have been made from time to time. The entire expenditure on the Erie Canal up to 1886 had been $133,000,000.

LAKE CHAMPLAIN AND HUDSON RIVER.

The present route of this canal is from Sorel, on the St. Lawrence River, 46 miles below Montreal, up the Richelieu River through the St. Ours Lake to the Basin of Chambly, thence up the Chambly Canal to St. Johns and the River Richelieu to Lake Champlain, the distance in Canada being 81 miles, thence up Lake Champlain. At Whitehall, the southern end of Lake Champlain, the Champlain Canal is entered, and connection is obtained with the Hudson River. The total distance to Albany, 7 miles of which is by the Erie Canal, is 265 miles. The total lockage from the St. Lawrence River to the summit level of the Champlain Canal is 136¼ ft. upwards, and the total lockage down to Albany 150 ft. The total distance to New York by this route is 411 miles. The canal is generally of very moderate proportions, being about 36 ft. wide at the bottom, with 7 ft. of water on the sills.

RAILROADS.

The immense commercial business which is transacted annually at the lake ports may be appreciated by an examination of the following statement of the traffic at Chicago in 1889:

Length of main lines of railroad terminating at Chicago	54,411 miles.
Number of freight cars received and forwarded	4,248,769 cars.
Tons of freight received and forwarded	43,013,444 tons.

While the railroads with their important facilities carried a larger part of the products westward, the record of 1889 shows that there were transported on the lake two-thirds of all the cereals that went eastward.

HARBORS.

The present policy of the U. S. Government is to improve the harbors and entrance channels of the principal ports to a depth of 20 ft. In harbors of minor importance, the depth of the entrance to depend upon circumstances. The average depth at present in the harbors of the important ports is 16 ft.

INCREASE IN THE SIZE OF VESSELS.*

In 1869, 36 of the largest propellers on the Great Lakes averaged about 700 tons net register, ranging from 961 to 583. The draft loaded was about 11 ft., greatest draft 11½ ft. In 1890, what is called the business fleet of the Great Lakes, consisted of 2,055 vessels of 846,360 net register tons, valued at $58,125,500. Of these 1,153 are steam vessels, 232 of these steamers are over 1,000 tons register, 110

*See also ENG. NEWS for March 7, 1891.

are over 1,500 tons, and half of the larger class range from 1,600 to over 2,100 tons net register, and carry a cargo of 2,850 to over 3,700 tons. The draft of these vessels is at present limited by the depths of the channels and harbors, being a maximum of about 16½ ft., but many of them could safely and profitably load to 19 or 20 ft.

The Inland Lloyd Register of 1886 shows a total valuation of lake vessels of $30,597,450, against $58,128,500 in 1890. The type of vessels also has greatly changed. In 1886 there were only 21 steamers of over 1,500 net register tons. In 1890 there were 110 such steamers.

VOLUME OF LAKE TONNAGE.

A recent article in *Bradstreet's* gives some surprising statistics of the commerce of the Great Lakes. During 234 days of navigation last year, tonnage passed through the Detroit River to the amount of 19,000,000 tons, 10,000,000 tons more than the entries and clearances of all the seaports in the United States, and 3,000,000 tons more than the combined foreign and coastwise shipping of Liverpool and London. This does not include traffic between Lakes Superior and Michigan or Lakes Erie and Ontario, or local traffic between ports on these lakes. Nearly three times as many boats yearly pass through the St. Mary's Falls Canal at Sault Ste. Marie as through the Suez Canal, with an aggregate tonnage of 7,221,935 in 1889, against 6,783,187 for the Suez Canal, though with only 234 days of navigation, whereas the Suez Canal is open all the year round. The figures for the lake shipbuilding are equally striking. Last year the tonnage constructed by lake builders was almost exactly equal to that of the Atlantic, Gulf and Pacific shipyards combined.

While this unprecedented increase of commerce upon the Great Lakes has been going on during the last few years, and is evidently destined to increase to still greater proportions, the water-ways out of the eastern end of Lake Erie and beyond to the sea have had no appreciable increase; in fact, there has been a decrease during the last 15 years. The Erie Canal is carrying no more than it did many years ago, and through the Welland and St. Lawrence River canals there has been practically no increase. In 1883 the total tonnage on the Welland Canal was 880,957; in 1887, 787,307; on the St. Lawrence Canals in 1883, 1,847,865 tons, and in 1887, 1,715,295 tons. There is no question that one of the principal reasons for the commerce through the canals east of Lake Erie remaining practically stationary, or decreasing, is the fact that they are not adequate for the business.

SAVING BY WATER TRANSPORT.

From careful records kept by the United States Government Engineer in charge of the St. Mary's Falls Canal, it was ascertained that the cost per ton per mile of carrying freight an average distance of about 800 miles was, in 1887, 2.3 mills and in 1889 1.5 mills. Rates on other lake lines favorably compare with this. It is estimated by Mr CHARLES H. KEEP, Secretary of the Lake Carriers Association, in a paper addressed to the U. S. Congress, Dec. 5, 1890, that the value of the entire cargoes carried on the lakes last season was $305,432,042. He estimated that the average distance of carriage of the entire commerce of the Great Lakes is 566 miles, which would make the total ton-mileage for 1889 15,518,360,488. The entire mile-tons of railroad carriage in the United States in the year ending June 30, 1889, was 68,727,223,146; in other words, the freight service on the Great Lakes is 22.6 per cent of the total freight service rendered by all of the railroads of the United States. At the average railroad rate of all the freight moved in 1889, according to the statistician of the Interstate Commerce Commission, 9.22 mills per ton per mile, the cargoes carried on the lakes in that year would have cost the shippers $143,079,283. Adopting 1½ mills per ton per mile as the average cost of lake transportion the entire cost for the season of 1890 was $23,177,541. The saving to the public therefore by water transportation on the lakes in that single year was $119,891,743. Much of the heavy freight has been carried for considerably less than 1½ mills per ton per mile. Anthracite coal is carried from Buffalo to Duluth and Superior, a distance of 1,000 miles for 30 cts. per ton, or ⅓ mill per ton-mile. The total tonnage of freight moved in the Central Northern and Northwestern groups of states, according to Poor's Manual, was, in 1888, 195,773,526. The increase of foreign trade at the Atlantic ports was, between 1870-89, from 9,155,659 to 15,952,119 tons.

DECREASE IN FREIGHT RATES.

A detailed history of the reduction in rates between the Northwest and the Atlantic seaboard by river, canal and rail would be of great interest in this discussion. We cannot, however, give more than some of its salient points.

During 1852 (the first year of free competition between canals and railroads) the New York Central R. R. hauled flour from Buffalo to Albany for 60 cts. per bbl., which is nearly 50 cts. below the average price by canal for nearly 20 years subsequent to its opening. The above is equivalent to about $6 per ton, or a little over 2 cts. per ton-mile. On the railways of the State of New York in 1855 the average receipts per ton-mile for freight were 2.79 cts.. About this time a report signed by the superintendents of the four trunk lines claimed that the lowest rates at which ordinary freight could be carried and pay interest and expenses was an average of 2 cts. per ton-mile for heavy agricultural products, 3 cts. for groceries, and 4 cts. for drygoods. In 1858 the Lake Shore & Michigan Southern Railway forwarded from Chicago to New York 43,304 tons of freight at an average rate of 2.38 cts. per ton-mile.

The average charge per ton of wheat from Chicago to New York during 1868 to 1872 was as follows: All water route, 5.54 mills per ton-mile. The average of the 4 years, 1868 to 1872, lake and rail route, 6.66 mills; all rail, 12.79 mills. The rate per ton-mile by the present shortest rail route is about 5 mills. During 1878 the wheat rate by water from Chicago to New York was something under $3.30 per ton or 2.3 mills per ton-mile.

During the season of 1879 grain was shipped from Chicago to Liverpool for 17 cts. per bu., a rate but little greater than was paid for transportation by canal from Buffalo to New York only 10 years before. In 1890 grain was shipped from Chicago to Liverpool for 9¾ cts. per bu. The average lake rates from Chicago to Buffalo on wheat have been as follows:—

	Cts. per bu.		Cts. per. bu.
1861	11	1875	3½
1865	9.7	1878	3.1
1870	6.2	1889—90	2½

Large steamers with barges in tow can transport grain at 2 cts. per bu., between Chicago and Buffalo, with a profit.

(To be continued.)

The South Orange Sewerage Question.

A lively controversy is promised at South Orange, N. J., over the proposed new sewerage system, of which the following are the facts, as we understand them:

The village, under the direction of the last Board of Trustees, has succeeded in introducing a water supply into the village derived from a well driven by the Mountain Water Co., near Summit, N. J., and brought to the village by a pipe-line through the villages of Milburn and Maplewood. The present Board is ambitious of securing for the village the benefit of a sewerage system, and acting under the advice of Mr. CLARENCE BARRETT, has formulated a scheme of sewerage, disposing of the sewage on a farm in the town of Milburn, about half a mile distant from the centre of the village, and about two miles south of South Orange village line. Some doubt has been expressed as to whether sufficient consideration has been given to the question before proceeding with the construction of the system. Two meetings have already been had, open to the public for expression of opinion, and the Trustees will hold an open meeting for further consideration on the 16th inst. Sewage disposal is to be, if carried out as proposed, by downward filtration on an area of about 12 acres, which it is thought by the Trustees will suffice for the population of South Orange, Orange Valley (that is, the part of Orange lying on the Rahway watershed) and West Orange, embracing a population in the neighborhood of 10,000 people Whether it actually will do this or not, and whether the system is the best one for the village to adopt, are the points in dispute. It is to be understood that it is not proposed under this plan to precipitate the sludge prior to filtration, except as it may separate by natural gravity in a large tank.

Circulation Plates in the Water Space Around Locomotive Fire-Boxes.

In our issue of March 21 it was suggested that the circulation in the water space around locomotive fire-boxes might be improved by placing vertical plates in the water space to divide the ascending current of mingled steam and water from the descending current of water. A correspondent writes us that in 1873 an engine was built for the New York, Providence & Boston R. R. with a thin sheet of iron in the water space around the fire-box, dividing it into two parts. The engine gave no trouble by priming, as was suggested might be the case, nor in any other way.

In reply to inquiries concerning the engine, Mr. L. M. BUTLER, Master Mechanic of the road, writes us that the circulation plates rise about to the height of the crown sheet at the sides, and terminate at the bottom about 4 ins. above the mud ring. The stay-bolts are screwed through these sheets and hold them at the center of the water space. The water space is 3 ins. wide all around.

Mr. BUTLER thinks that the plates do not improve the steaming qualities of the boiler, and that they shorten the life of the stay-bolts by holding them at the center and concentrating the bending strains due to expansion at that point, instead of at the outside sheet. The plates have been allowed to remain in, however, as they could not be conveniently removed.

As was stated in suggesting the use of circulating plates, it is to be expected that plates improperly arranged will do more harm than good. One error in the design of this boiler seems to have been the division of the water space into two equal parts. The quantity of water circulated in a boiler, according to Mr. GEO. H. BABCOCK, is greatest when the density of the mingled steam and water in the rising column is one-half that of the water in the descending column. The circulating plates should be placed, therefore, to give one-third the space on the descending side and two-thirds on the ascending side. Perhaps if the plates were bent at the top to direct the rising current of steam over the crown sheet, the results would be more favorable.

Mr. BUTLER rightly objects to having the stay-bolts held at the middle, so that the bending is concentrated there; but any trouble from this cause could be obviated by punching the plate with holes ¼ in. larger than the staybolt, and keeping it spaced by loose washers on a few of the bolts. It is evident that the experiment has at least done no serious injury to the boiler, or the engine would not be still running after 18 year's service. We shall be glad to hear of any other experiments in this direction. In every other type of boiler of which we are aware, better circulation, consequent on the separation of the ascending from the descending currents, has resulted in a marked increase in evaporative efficiency and a reduction in the deposit of scale. This does not prove that the efficiency of the heating surface of the locomotive firebox, which is already very high, can be bettered by the use of circulating plates; but it indicates that the experiment is at least worth trying.

Railways in British Guiana.

Two new railways are projected for this South American colony, and proposals for their construction are to be received by the Government Secretary at Georgetown, Demerara, in June. The following particulars are given from information furnished by Mr. J. M. MOORE, Colonial Civil Engineer. One line, 12 miles long, is to run from Philadelphia to Vreeden Hoop, opposite Georgetown, on the Demerara river, which is ¾ mile wide. The other line is to Blairmont. Intending contractors are to make their own propositions as to route, gage, etc., and the company would have to raise the capital on the 4% government guarantee, and to work the line.

The country is very easy for railway construction, the level never varying more than 3 ft. in the whole distance. It would be necessary to keep the subgrade about 3 ft. above the level of the surrounding country. During part of the year the rainfall is exceptionally heavy, 100 ins. having fallen during 1890. The soil is principally clay, and the price of earthwork varies from 5 to 10 cts. per cu. yd. Rock only exists in the interior, whence granite for bridge piers, etc., can be floated down on flat boats, and will cost about $6 per cu. yd. at Georgetown. Concrete costs about $13 per cu. yd., and greenheart timber 35 cts. per cu. ft. Wages are about 40 cts. to 56 cts. per day for laborers, and 84 cts. to $1 per day for carpenters and masons. There will only be 3 bridges of any size, 200 ft., 150 ft. and 100 ft. long respectively, each of which will require a draw span. Where the lines intersect the sugar estates there will be at least one navigable canal 15 ft. wide and two draining trenches 10 ft. wide, to be crossed at every 300 yds. with bridges of hard wood or wrought iron beams. The whole of the Vreeden Hoop line will run through sugar estates. The other line will be partly through sugar estates, waste land and land cultivated for farm produce. There is a large coolie population living on the Vreeden Hoop district, and it is expected that the passenger traffic will be large. No detailed estimates of traffic for this line have been furnished, but it is thought to be sufficient to warrant the construction of the line. During the last 6 months of 1890, 5,700 passengers went to

ELEMENTS OF WEATHER IN THE UNITED STATES, OF MOST INTEREST TO ENGINEERS, FOR THE MONTH OF MARCH, 1891.
[Furnished to ENGINEERING NEWS by the Chief Signal Officer, U. S. A.]

	STATION.	Temperature. (Deg. Fah.) Average.	Max.	Min.	Range.	Wind. Velocity in miles per hour. Average.	Maximum.	Direction at time of max. velocity.	Precipitation.—Rain and melted snow. Inches. Total.	Heaviest in 24 hours.	Number of rainy days.
NORTHERN CITIES.	Northfield, Vt	24.8	49	−15	64	10.7	60	SW	2.68	0.60	15
	Portland, Me	30.4	53	2	51	10.8	33	E	5.48	2.19	13
	New York City	37.8	61	9	52	15.1	45	SW	4.22	0.87	13
	Pittsburg, Pa	37.6	65	11	54	7.4	42	SW	3.11	0 79	17
	Chicago, Ill	30 6	57	7	50	19.3	56	SW	2.13	0.58	15
	Omaha, Neb	28.6	62	−6	68	9.8	34	NW	2.26	0.84	13
	St. Paul, Minn	23.5	48	−9	57	7.2	33	NE	0 94	0.29	10
	Duluth, Minn	19.5	38	−12	50	6.5	30	NE	3.13	0.83	15
	Bismarck, N. Dak	15.6	50	−33	83	9.7	36	NW	1.24	0.81	8
	Average	26.5	53.7	−5.1	58.8	10.7	41	.....	2.80	0.87	13
SOUTHERN CITIES.	Washington City	39.0	60	17	43	9.0	34	NW	8.84	1.83	15
	Louisville, Ky	41.7	63	16	53	8.8	50	SW	6.57	1.62	19
	St. Louis, Mo	39.0	68	9	59	13,9	37	SW	2.29	0.70	13
	Savannah, Ga	56.0	78	35	43	8.6	35	NE	5.08	2 04	14
	Leavenworth, Kan	34.4	68	1	67	8.6	30	SE	3.16	0.65	13
	Jacksonville, Fla	61.6	82	38	44	8.3	34	SW	4.62	1.40	13
	Chattanooga, Tenn	47.6	69	24	45	6.6	30	NW	9.16	3.09	21
	New Orleans, La	60.6	80	39	41	10.0	36	NE	2.67	1.04	8
	Memphis, Tenn	48.0	76	26	50	9.0	38	W	7.57	2.85	14
	Palestine, Tex	52.6	80	26	54	8.2	26	S	2.63	0.58	10
	Average	48.0	73.0	23.1	49 9	9.1	33	.....	5.18	1 58	14
WESTERN CITIES.	Helena, Mont	23.2	54	−20	74	4.5	48	SW	1.37	0.60	10
	San Francisco, Cal	55.0	76	43	33	7.9	26	SW	1.96	0.68	12
	Salt Lake City, Utah	38.0	64	12	52	6.3	25	SW	1.66	0.84	15
	Denver, Col	32.0	68	4	64	7.6	36	NE	3.10	1.28	14
	Yuma, Ariz	63.4	87	42	45	8.3	48	W	T	T	0
	Santa Fé, N. Mex	36.4	63	9	54	7.7	40	NW	.59	0.27	10
	Average	41.3	68.7	15.0	53.7	7.0	37	.....	1.95	0.61	10

Blairmont by steamer, and large numbers went by road.

The present line from Georgetown along the coast to Mahaica is 20 miles long, and has a gage of 4 ft. 8½ ins. It was opened in 1864, and is owned by an English company, with offices in London. According to Poor's Manual of Railroads, the track is laid with 65 lb. rails and the equipment consists of 10 English locomotives, averaging 28 tons each, 19 passenger cars and 204 freight cars. Construction and equipment to Dec. 31, 1888, $1,296,000; gross earnings for 1888, $153,984; expenses, $86,839; net earnings, $67,145. Capital stock, $1,400,000. Average dividend about 4½%. Mr. F. A. MASON is President and General Manager. The local offices are at Georgetown.

PASSENGER RATES PER MILE ON EUROPEAN RAILWAYS are stated to average approximately as follows:

Countries.	1st class. cts.	2d class. cts.	3d class. cts.
France	4.0	3.0	2.2
England	4 1	3.1	2.0
Belgium	3.1	2.4	1.6
Holland	3.4	2.7	1.7
Germany	3.2	2.4	1.6
Hungary	2.4	1.6	0.8
Switzerland	3.4	2.4	1.7
Italy	3.6	2.5	1 6
Spain	4.2	3.2	2.0
Russia	4.8	3.5	1.8

In comparison with these figures, taken from a report to the French Chamber of Deputies, our own average rate of 2 17 cts. appears quite low.

PIG IRON PRODUCTION is still declining, according to the figures in the *Iron Age*. The record up to April 1, is as folows:

	Jan. 1.	Feb. 1.	Mar. 1.	Apr. 1.
Coke furnaces:				
In blast	143	125	113	94
Capacity per week, tons	112,153	94,473	85,693	66,300
Anthracite furnaces:				
Inblast	101	95	93	91
Capacity per week, tons.	43,166	40,212	38,543	36 598

The falling off has been practically universal until recently, but a few Southern furnaces have again been blown in and one of them, the Hattie Ensley, at Sheffield, made an average of 150 tons daily during a run of 31 days, an excellent showing for a Southern furnace.

THE DEEPEST WELL IN THE UNITED STATES is proposed at Wheeling, W. Va., by the Wheeling Development Co., which is drilling for gas or oil, and has now gone down 4,108 ft. This makes it the third deepest well in the country, the Westinghouse well at Pittsburg leading at 4,618 ft., and a well at Erie, Pa., coming next at 4,460 ft. Prof. J. C. WHITE has recommended to the owners of the well that they continue it down in the hope of reaching the corniferous limestone, which is the rock in which the Canadian oil and gas deposits occur. He thinks this may be reached at from 4,500 to 4,700 ft. If this is done the depth of the Westinghouse well may perhaps be exceeded.

THE WORLD'S POPULATION IN 1890 is estimated in the *Proceedings* of the Royal Geographical Society for January, 1891, as follows:

	Population.	Per cent. of total.	Av. per sq. mile.	Inc. per. decade. Per cent.
Europe	380,200,000	25.6	161	8.7
Asia	850,000,000	57.1	57	6
Africa	127,000,000	8.5	11	10
Australasia	4,730,000	0.3	1.4	30
North America	89,250,000	6.0	14	20
South America	36,420,000	2.5	5	15
Totals	1,487,600,000	100.0	31	8

It will be clear from this table that until there are at least 500,000,000 inhabitants of North America, no part of it is likely to be very seriously crowded.

CONSTRUCTION NEWS.

RAILWAYS.

EAST OF CHICAGO.—Existing Roads.

Pennsylvania.—Tracklaying on the cut off between Downington, Pa., and Morrisville, Pa., is making rapid progress. All but about 7 miles of the section between Morrisville and the Schuylkill River has been completed. From the Schuylkill River west to Glen Loch, where a connection will be made with the main line, the grading is well advanced.—The contract for the line from South Fork station to the Cambria and Bedford county line, 12 miles, has been let to Jas. Bennett and A. S. Talbott, of Greensburg, Pa. Work is now in progress.

Baltimore & Ohio.—Plans are reported completed for the extension of the Virginia Valley R. R. to Roanoke, Va., a distance of about 54 miles, where connection will be made with the Roanoke & Southern R. R., and an outlet secured to the south.

Grand Trunk.—An effort is being made by the people along the route to secure the construction of a branch from Peterborough to Bobcaygeon, Ont., a distance of 20 miles.

New York, Pennsylvania & Ohio.—Surveys are reported in progress for a line from Loveland's Station to Youngstown, Ohio.

Projects and Surveys.

Alliance & Northern.—Incorporated in Ohio to build a line of railway from Alliance, O., to Southington, O. Among the incorporators are: Harvey H. Brown, E. H. Bourne, J. H. Dempsey and D. B. Chambers. It is the intention of the company to purchase the property of the Lake Erie, Alliance & Southern R. R.

Baltimore & Ohio Southwestern Terminal.—Chartered in New Jersey for the purpose of building and equipping railways. Among the incorporators are: Orlando Smith, Walter C. Taylor and Chauncey G. Parker.

Westerly & Jewett City.—A meeting of the citizens was held at Westerly, R. I., April 14, to take measures toward promoting this enterprize.

Reading & Southwestern.—At a recent meeting of the directors it was decided to award the contracts for building this road at once. The road is to run from Reading to Mohrsville, Pa., 5 miles.

Don & Scarboro.—This company is applying for power to construct a railway from a point in Toronto, Ont., to the village of Boston Corners, in the township of Scarboro, Ont.

Indiana Northern.—Chartered in Indiana to build a railway from the south line of the Lake Shore & Michigan Southern R. R. to the north line of the Indiana & Lake Michigan R. R., near the town of South Bend, Ind. The line will be about one mile long. Jas. Oliver, South Bend, Ind., President.

Tuscarora Valley.—Chartered in Pennsylvania to build a railway from a point in Milford township to a point in Lock township, Juniata County.

SOUTHERN.—Existing Roads.

Fincastle and Troutville.—The contract for building this railway from Fincastle to Troutville, Va., 6¾ miles, has been let to the Roanoke & Botetourt Construction Co., work to begin May 1. E. B. Simmons, of Fincastle, Va., is President.

Southern Investment Co.—The Blackville, Alston & Newberry, and the Barnwell railway companies, operating together a line of railway from Seivern, S. C., to Barnwell, S. C., 39 miles, have been consolidated, and the above company has been organized to build extensions from Barnwell to Allendale, S. C., 40 miles, and from Seivern north. Work is already in progress on the section from Barnwell to Allendale, with a force of about 500 men and 250 teams. The work is to be completed in 90 days. The Southern Investment Co. is capitalized at $250,000, with the following officers: Rudolph Siegling, of Charleston, President; Mike Brown, General Manager, and R. R. Pinckney, Secretary and Treasurer. The board of directors are: F. W. Wagener, Mike Brown, James Simons, Henry Offerman and Rudolph Siegling.

Carolina, Knoxville & Western.—An attempt is being made by the people along the route to consolidate the interests of this company with those of the Carolina, Cumberland Gap & Chicago R. R. Co., and secure the construction of a railway from Augusta, Ga., to Knoxville, Tenn. The Carolina, Cumberland Gap & Chicago R. R. is now in operation from Aiken to Edgefield, S. C., 23 miles. It is proposed to extend the line from the latter place via Abbeville, S. C., to Greenville, S. C. From Greenville to Marietta, S. C., 14 miles, the Carolina, Knoxville & Western R. R. Co. has a line in operation, and it is proposed to extend this line, as originally intended, to Knoxville, Tenn. This would form a line from Aiken, S. C., to Knoxville, Tenn. A large amount of grading has been done along the line.

Georgia, Southern & Florida.—Work has been discontinued on the line from Tifton to Thomasville, Ga. It is thought that it will be resumed in a short time.

Kansas City, Memphis & Birmingham.—Work has been commenced on a branch from a point on the main line near the Little Warrior River, about 18 miles west of Birmingham, Ala., to the Bessie coal mines.

Louisville & Nashville.—A survey, reported to be in the interest of this company, has recently been made for a railway from Sylacauga to Wetumpka, Ala.

Macon, Dublin & Savannah.—In a recent newspaper interview, President Jas. T. Wright, of the Illinois & Georgia Improvement Co., which has the contract for building this road, speaks as follows in regard to the progress of work:

> Fifty-three miles of the line from Macon to Dublin have been graded, 23 of which are in operation as far as Jeffersonville, the county site of Twiggs. From this time the tracklaying will be pushed forward at the rate of 1 mile per day, and it is expected that the road will be in running order to Dublin by May 15. The rails to that point have all been purchased, paid for and delivered, together with the full equipment of the road, including passenger coaches and other rolling stock. From Dublin the work will be prosecuted without delay to Savannah, 100 miles, and, it is confidently expected will be finished by September next. The whole length of the line from Macon to Savannah when completed will be 153 miles, and the estimated cost will not exceed $13,000 per mile.

Chattanooga Southern.—An official of this road is reported as saying that work is progressing rapidly. The long tunnel near Kensington is about completed. Seventy-five men are at work laying track, and from a half to three-quarters of a mile per day is being put down. The entire line is already graded, so that the laying of rails will about complete the road.

Glasgow Belt.—This road will be standard gauge, 6 miles long, and will connect the Richmond & Allegheny R. R. at Glasgow, Va., with the Shenandoah Valley R. R. at Glenwood, Va. E. D. Swift, of Glasgow, Va., has the contract. Contracts will be let soon for the rolling stock. The Rockbridge Co., of Glasgow, is buiding the road.

Montgomery, Tuscaloosa & Memphis.—Work on the Montgomery, Tuscaloosa & Memphis R. R., which was partially suspended in January, has been very generally resumed all along the lone. The grading is finished between Montgomery and Maplesville, and about half of the grading between Maplesville and Tuscaloosa has been completed. All the line except about 10 miles is now cov-

ered by grading forces, and it is thought that the road will now be pushed to completion.

Norfolk, Albemarle & Atlantic.—This company has decided to change its road to standard gage; work to begin within 60 days. The road runs from Norfolk, Va., to Virginia Beach, 17.9 miles. J. M. Dickey, Norfolk, Va., General Superintendent. The company will also increase its rolling stock.

Jacksonville Mining & Manufacturing Co.—Geo. H. Montgomery, Jacksonville, Ala., Chief Engineer, writes as follows:

This road will be 9½ miles long, and will run from the southern limit of the town of Tredegar, Ala., to Iron Mountain, passing through the mineral lands owned by the company. Three miles of the line have been located and the contract for construction let, and the preliminary surveys have been completed for the remaining 6½ miles. The work will be quite easy; highest embankment 8 ft., and deepest cut 9 ft. The maximum grade will be 1½%, and the maximum curve 6°. There will be about 300 ft. of trestle work. The object of the road will be to develope the mineral lands along the route, and its principal business will be in iron ore, manganese, lime stone and fire clay. J. W. Burke is President.

Projects and Surveys.

Bennettsville & Gibson Station.—Organized in South Carolina to build a line of railway from Bennettsville, S. C., to Gibson Station, N. C., 9 miles. Surveys will commence at once and the line will be constructed this season. President, F. B. Gibson, and Secretary and Treasurer, C. P. Townsend, both of Bennettsville, S. C.

Branchville & Bowman.—The organization of this South Carolina company has been completed by the election of the following officers: President, Samuel Dibble; Vice-President, B. H. Moss, and Superintendent, E. T. R. Smoak. The company has purchased the property of the Smoak Tramway Co., operating 6 miles of narrow gage railway in Orangeburg Co., and will extend the road and operate it for general traffic.

Andalusia.—Incorporated in Alabama to build a railway from Andalusia, Covington Co., Ala., to the Conecuh River, near Bullock's Bridge. Among the incorporators are: W. C. W. Cawthorn, J. T. Bradshaw and John W. Prestwood.

Charleston Mining, Manufacturing & Improvement Co.—This company will, it is stated, build a belt railway at Charleston, W. Va., to connect its property with the Norfolk & Western and the Baltimore & Ohio railways.

Broadway & West Virginia.—Surveys will be made for a line from Broadway to Riverton, W. Va. Surveys have already been completed for a line from North River Gap to Broadway, W. Va., 20 miles. The Virginia Land & Improvement Co. is making the surveys. F. H. Skeele, 38 Wall St., New York City.

Savannah & Isle of Hope.—Surveys are in progress for this railway from Walter's road to Tunderbolt, near Savannah, Ga.

Georgia.—J. S. Crapp, of Tallapoosa, Ga., is surveying the route for a 20-mile narrow gage railway.

NORTHWEST. Existing Roads.

Duluth, Pierre & Black Hills.—The engineers have commenced cross-sectioning on the 45-mile section between Pierre and Aberdeen, S. Dak., and construction will begin soon. The road is to run from Pierre, S. Dak., to Oakes, N. Dak, 181½ miles. Chief engineer, B. P. Tilden, Aberdeen, S. Dak.

Chicago, Quincy & Keokuk.—This company will begin construction of its road from Quincy to Niota, Ill., within 60 days, the right away has all been secured, and the line located. The length of the road is 60 miles. The line passes through Keokuk and Hamilton, and connects with the main line of the Santa Fé to Kansas City at Niota. W. R. Arnold, of Chicago, Ill., is President, and W. A. Colhoun, of Green Bay, Wis., is Chief Engineer.

Chicago & Eastern Illinois.—Work has been commenced on the line from Tuscola to Shelbyville, Ill. It is expected to have the road, with the exception of the bridge across the Kaskaskia River, completed within 90 days.

Winona & Southwestern.—Work has been resumed on the division from Spring Valley, Minn., to Osage, Ia. The grading is nearly completed, only about six weeks' more work remaining to be done. Tracklaying will begin May 1, and it is expected to have the line completed to Osage during June.

SOUTHWEST. Existing Roads.

San Antonio & Aransas Pass.—A dispatch from Corpus Christi, Tex., says:

The San Antonio & Aransas Pass R. R. Co. has started a surveying party from Alice, where the road connects with the Mexican National R. R. Three lines will be surveyed to determine the best route to some point on the Rio Grande River. When this is done the company will extend its line from Alice to Mexico, possibly to Reynosa.

Missouri Pacific.—Surveys are in progress for an extension of the Kansas & Arkansas Valley R. R. from Fort Gibson, Ind. Ter., to Denison, Tex., passing through the Indian Territory coal fields.

Kansas City, Watkins & Gulf.—Tracklaying is making good progress on the extension from Lake Charles, La., north.

Mississippi River & Bonne Terre.—The work of locating the southern extension of this railway from Bonne Terre, Mo., to Doe Run, 15 miles south, is completed, and the grading will be begun in a short time. The extension will run directly through the rich mining district of Flat River, and it is expected that it will be completed within the next six months. This line, which is owned by the St. Joseph Lead Co., connects with the Mississippi River and also with the Iron Mountain Railway at Riverside, 27 miles south of St. Louis. When completed to Doe Run it will have an entire length of 47 miles.

Gulf, Colorado & Santa Fe.—It is reported that work will begin on a branch from Conroe, Tex., to a point in Liberty Co., about 40 miles distant, in a few weeks. The road will penetrate a rich lumber region.

Bridgeport & Decatur.—It is stated that the Bridgeport Coal Co. has awarded contract to eastern parties for building and equipping its proposed railway from Bridgeport to Decatur.

Sedalia, Warsaw & Southwestern.—The Sedalia, Warsaw & Southern Ry. Co., operating a narrow gage railway from Sedalia to Warsaw, Mo., 42 miles, has been reorganized under the above name. The road is to be changed to standard gage.

Projects and Surveys.

Iberia & Vermillion.—Chartered in Louisiana to build a railway from New Iberia, La., west to Abbeville, La., about 17 miles. The officers are: President, Aug. Erath; Vice-President, Fred. L. Gates; Secretary, Jas. A. Lee, and Treasurer, E. A. Pharr. A meeting will be held at New Iberia, La., May 12, to vote on the proposition to levy a 5-mill tax for 10 years in aid of the enterprise.

San Antonio & Oakville.—An effort is being made by the people along the route to secure the construction of a railway between San Antonio and Oakville, Tex., 80 miles. The line has been surveyed. Sam. J. Whitsett, Pleasanton, Tex., is interested.

ROCKY MT. AND PACIFIC.—Existing Roads.

Northern Pacific.—The Lewistown & Southeastern R. R. Co. has been organized to build an extension of the Northern Pacific R. R., from Lewistown, Idaho, into the Seven Devils mining region. It is stated that work will begin at once.

Union Pacific.—It is reported that arrangements have been made between the officials of this company and the various mining and smelting companies at Pioche, Nev., whereby construction will be resumed on the extension from Milford, Utah, to Pioche, Nev. A large portion of the grading was completed and several miles of track were laid last year.

Pecos Valley.—It is reported that construction will be resumed at an early date upon this New Mexico railway, and the line completed from Eddy, N. Mex., up the Houelo and Bonito valleys to San Pedro, N. Mex. The line was built from Pecos City, Tex., to Eddy last year.

Burlington & Missouri River.—The Central Ry. Co. has been chartered in Colorado to build a branch of this road from Coal Creek Station to Boulder, Colo.

Projects and Surveys.

Castle Valley.—Chartered in Utah to build a railway from Price Station, on the Rio Grande Western R. R., to Pittsburg, Utah, about 40 miles. Among the incorporators are: Alex. Johnson, B. F. Thornburg and Milando Pratt; all of Salt Lake City.

CITY TRANSIT.

Electric Railways—New lines or extensions of existing systems are reported as probable in the following places: Sioux City, Ia.; Mason City, Ia.; Newark, N. J., address the Rapid Transit R. R.; Hendersonville, N. C., address C. E. Wilson; Aberdeen, Wash.; Houston, Tex., address I. D. Holmes; Martinsburg, W. Va., address S. W. Walker; Oakland, Cal., address the Berkeley Rapid Transit Co.; Missoura, Mo.; Northport, Me.; Winona, Minn.; Clayton, Mo., address D. R. Black; Albany, N. Y., address the Albany Ry. Co.;

Biddeford, Me.—The aldermen have granted permission to the Biddeford & Saco R. R. Co. to operate an electric line through the city, provided the company will agree to run cars throughout the year.

Quincy, Mass.—A bill has been introduced in the legislature to incorporate the Quincy Electric Freight Ry. with a capital not to exceed $300,000.

Syracuse, N. Y.—It is reported that the Consolidated and the People's R. R. Cos. will be granted permission to substitute electricity for horses on all lines in the city.

Baltimore, Md.—The directors of the City Passenger Ry. Co. have practically determined to operate a portion of their lines by electricity. The Thomson-Houston Co. estimates the cost of the proposed plant at $300,745. It is proposed to run 30 16-ft. 15-HP. cars and operate a station with a 500-HP. generating and 600-HP. steam plant.

Selma, Ala.—It is reported that the Selma Street Ry. Co. will extend its lines 7 miles, and change the motors in the city from steam to electrical.

Bristol, Tenn.—S. L. Nicholson has been appointed Superintendent of the Bristol Belt Line Ry., and has begun to adapt the lines of the company for electric traction. The road will be over 8 miles long and operated by the Rae system.

Seattle, Wash.—The County Commissioners have granted a 25-year franchise to the Rainier Power & Ry. Co. to operate either electric or cable railways for freight and passengers on a number of streets,

Cable Railway.—*Washington, D. C.*—The Washington & Georgetown R. R. Co. has been granted permission to begin constructing its lines.

Dummy Railways.—*Augusta, Ga.*—The Railroad Committee of the City Council has decided to report favorably on the petition of the Belt Line Co. for the use of streets leading out to Murray Hill for a dummy railway.

Fort Payne, Ala.—The Fort Payne Street Ry. Co. will build a 4-mile line.

St. Augustine, Fla.—The North Beach Ry. Co., J. N. Hazlehurst, manager, is reported as about to introduce steam motors on its lines.

Omaha, Neb.—Work on the Benson motor line will probably begin soon. This line will connect with the Walnut Hill Ry., now under construction, giving a through line to a point nearly 5 miles from the center of the city.

Helena, Mont.—Receiver Clark, of the motor line, recommends discontinuing the dummy service and adopting electric motors.

Monmouth, Ore.—Subscriptions are being taken here and in Independence for surveys to continue the motor line to Falls City.

San Jose, Cal.—The Board of Supervisors have granted a franchise for a double track line to Alum Rock Park, to be operated by the Hoskin's vapor engine.

Horse Railways.—New lines or extensions are reported as probable in the following places: Brattleboro, Vt., address S. N. Herrick; Suffolk, Va., address the Suffolk St. Ry. Co; Sheffield, Ala., address T. D. Radcliffe; Centralia, Wash.

New Companies—Menominee Electric Railway & Power Co., Menominee, Mich.; capital stock, $110,000. Peoples' St. R. Co., Charlestown, W. Va.; incorporators, W. Neill, H. D. Gibson, W. Campbell and others.

HIGHWAYS.

Massachusetts.—About $20,000 are to be expended this year on the construction of permanent roads round Lenox. The Pittsfield Board of Public Works has asked for $20,000 for highways and bridges.

New Jersey.—Moorestown is about to contract for two miles or more of telford paving on its principal streets. Riverton has also made an appropriation for a telford road running toward Moorestown, and it is hoped the two may be joined.

Pennsylvania.—Upper Darby is considering making a loan of $150,000 for road purposes. A special election is to be held April 28 to decide the matter. Mr. P. J. Walsh is Supervisor of Roads. The new Darby telford road is to cost the company $5,000 per mile. Mr. Henry T. Davis, of Davis & Harvey, Philadelphia, is President.

Ohio.—Lawrence Co. has voted to issue bonds for $150,000 for road improvements.

Michigan.—The Bay Co. Road Commissioners have awarded a contract for furnishing 1½-in. broken stone to Peter Malcolm at $1.75 and $1.95 per cu. yd. The contract calls for $20,000 worth of material.

Manitoba.—The provincial government appropriation for the current year for public work is about $90,000, of which about $30,000 will be expended on road improvements and wooden highway bridges.

BRIDGES, TUNNELS AND CANALS.

Bridges.—*Elizabeth, N. J.*—The Central R. R. of New Jersey will depress Union St. under the tracks, and will build a through plate girder bridge for four tracks. Clear span, 50 ft. Headway, 14 ft.

Columbus, O.—Bids will be received until April 20 for a two-span bridge with inclined end posts, spans 87.85 ft. and 159.5 ft. respectively. Frank J. Reinhard, County Auditor, Columbus, O.

Marietta, Ga.—J. M. Stone will receive bids until May 21 for the erection of two bridges, one 100 ft. in length, across Sopes Creek at Sorrell's Mill, and the other 120 ft. long, across Sopes Creek on the Canton & Powers Ferry Road.

Minnedosa, Man.—Tenders will be received until May 1 for constructing an iron bridge on Main St., Minnedosa, Man. R. H. Myers, Minnedosa.

Ottawa, Ont.—Tenders will be received until April 24 for constructing an iron bridge over the Rideau Canal, on Maria St. E. F. E. Roy, Secretary Department Public Works, Ottawa, Ont.

WATER-WORKS.

NEW ENGLAND.

Belfast, Me.—The length of the proposed supply main from the Little River dam to the hotel in Northport is 9,730 ft.

Goffstown, N. H.—A bill authorizing the fire precinct to construct works has passed the House.

Salem, N. H.—The Senate has repealed the charter formerly granted to the Salem Water-Works Co. and passed another or amended bill restricting the company to furnishing water to New Hampshire towns.

Dalton, Mass.—Authority to issue $10,000 of water bonds has been granted. It is reported that water from Egypt Brook will be conveyed to the reservoir.

Foxborough, Mass.—The water supply of this district has been extended.

Haverhill, Mass.—The city is taking steps to secure authority to build works. The property of the Haverhill Aqueduct Co. may be bought.

Hopedale, Mass.—It is reported as probable that the town will contract with the Milford Water Co. for 10 additional hydrants.

Palmer, Mass.—The works will be extended to Blanchardville. Pipe has been bought.

Marlboro, Mass.—About 2,500 ft. of mains are to be laid.

Pittsfield, Mass.—Extensions to the distributing mains have been authorized.

Meriden, Conn.—H. L. Sleiter, Superintendent, informs us that the city is to construct this year a new storage reservoir and pumping station. Water will be pumped to a distributing reservoir from which it will flow to the city with a head of 280 ft.

Waltham, Mass.—The city has been granted power to take 3,000,000 galls. of water daily from the Charles River.

Wallingford, Conn.—A petition has been presented to the burgesses asking that a special election be held on the question of laying a new supply main from Paugh Pond.

MIDDLE.

Buffalo, N. Y.—The South Buffalo Business Mens' Association urges the necessity for a better water supply in that part of the city. About $50,000, it is estimated, would be required to lay the necessary 12 and 10-in. mains.

Mayville, N. Y.—A. A. Van Dusen has been appointed President and G. E. Leet, Secretary, of the new Board of Water Commissioners. The Commissioners will probably employ an engineer and submit plans, which will finally be voted upon by the citizens. It is reported that Louis Bixby has made estimates of the cost of works.

Whitestone, N. Y.—A bill will be presented to the legislature authorizing College Point to sell water to Whitestone and other villages. This is in accordance with an informal proposition which, it is stated, has been accepted to supply Whitestone with water at the rate of 12 cents per 1,000 galls., provided Whitestone constructs a stand-pipe.

Rutherford, N. J.—The following is from J. P. Cooper, Mayor:

The application of the Hackensack Water Co. to supply this place with water has been referred to the ordinance committee. The preparing and passing of the ordinance will take about six weeks.

Somerville, N. J.—The company proposes to add a 1,000,000-gall. water power pump, and has voted to increase its capital stock from $50,000 to $75,000. Adolph Mack is President and W. H. Taylor, Secretary.

Lancaster, Pa.—Mayor Clark has been elected Chairman and George W. Eaby, Clerk, of the committee having in charge the construction of the reservoir, for which $150,000 has been voted.

SOUTHERN.

Max Meadows, Va.—The Max Meadows Water & Light Co. has been organized by J. H. Crockett, T. P. Maury and others; capital, $100,000.

Wilkesboro, N. C.—Estimates on the cost of works are wanted by F. W. Trogdon, Secretary Winston Land & Improvement Co.

Sumter, S. C.—The franchise recently granted Henry O. Reed, 206 Broadway, New York, provides for a daily supply of 500,000 galls. from flowing artesian wells 500 ft. deep, or less. If a flow cannot be secured at 500 ft. or less water may be taken from bored wells 100 ft. deep. There are to be 5 miles of mains and 55 hydrants.

Dawson, Ga.—The following is from W. B. Dawson, Mayor:

The American Pipe Manufacturing Co., of Philadelphia, have bought the franchise, granted some time ago, as reported. Water will be pumped from springs to a stand-pipe, and there will be 50 hydrants.

Newnan, Ga.—It is reported that arrangements will soon be completed for $50,000 water-works. J. S. Powell is Mayor.

Kissimmee, Fla.—It is reported that a proposition to build works has been made by the Kingsbur Manufacturing Co.

Ozark, Ala.—T. J. Fain, City Clerk, informs us that the water-works question is indefinite. If works are built it will probably be by the town, and water will probably be pumped to a stand-pipe. William Garner is Mayor. Population, 1,000.

Columbus, Miss.—About 2,500 ft. of 6-in. mains are to be added to the works.

NORTH CENTRAL.

Elwood, Ind.—D. H. Peck informed us that contracts were to be let April 13 for direct pumping works, estimated to cost $60,000. Population, 3,000. Address C. B. Stevenson, Newark, O.

Detroit, Mich.—Petitions for the laying of pipe in 13 streets have recently been ordered. The contract for 16, 24 and 30-in. valves has been awarded to the Galvin Brass & Iron Works.

Macomb, Ill.—J. S. Gash has sent the following:

The people voted in favor of works April 7. The estimated cost is $40,000. A well 1,000 ft. was sunk two years ago. A. B. Lightner is Mayor. Population, 4,000.

Springfield, O.—The House has passed a bill authorizing the issuance of $25,000 bonds to extend the mains.

Quincy, Ill.—The proposition for new works to be built by the city has been voted down, but it is said that the majority of the aldermen are in favor of city ownership, and that if the company does not agree to a reduction in rates another attempt to secure city works may made.

Peru, Ill.—At the election recently held it was voted to issue bonds for the construction of water-works. The works will cost $40,000. Chas. N. Ledlie, St. Louis, Mo., contracting engineer.

Holland, Mich.—The citizens have voted to expend $17,000 for water-works.

Salem, N. H.—The Salem Water-Works Co. has been incorporated.

Danville, Ind.—The town of Danville is agitating the question of water-works.

Oklahoma, Ind. Ter.—Consulting Engineer Charles H. Ledlie, St. Louis, Mo., is preparing plans and specifications for a complete system of works to be put in by a private company. Water will be pumped from the Canadian River to a large masonry tower. There will be about 8 miles of pipe, 16-in. and smaller, and 75 fire hydrants. Contracts will probably be let within 60 days.

Hannibal, Mo.—Extensive improvements will be made this years, including the construction of a 10,000,000 or 20,000,000 gall. reservoir. Charles H. Ledlie, St. Louis, Mo., is the company's Consulting Engineer.

NORTHWESTERN.

Clarinda, Ia.—T. J. Bracken, Chairman, informs us that a stand-pipe is contemplated, but that nothing definite has been decided on.

Grinnell, Ia.—The Council is talking of building works.

Albert Lea, Minn.—C. A. Briggs has sent the following:

At an election held April 7 the people voted $20,000 of bonds for works. It is proposed to pump water from artesian wells (evidently) already sunk to a stand-pipe. Address W. A. Morris. Population, 3,600.

Topeka, Kan.—The new works, it is reported, will consist of a new supply from the wells driven in the river, a new pumping station, about 5 miles of 18, 14 and 12-in. mains, and a 90 × 180-ft. stand-pipe. George H. Pierson is Engineer, and J. M. Walker Superintendent of Construction.

Jamestown, N. Dak.—An experimental irrigation station will be established here this year by the government.

SOUTHWESTERN.

Dallas, Tex.—The *News* is now sinking a well.

Fort Worth, Tex.—The Artesian Water Co. will sink a well about 850 ft. deep at the Natatorium.

La Grange, Tex.—The people have voted in favor of works. W. H. Wedbetter is mayor.

Torkio, Mo.—A franchise has been granted to D. Rankin. The works are estimated to cost $50,000.

Channings, Tex.—Works, taking a supply from an artesian well, are to be built by Davis & Baird.

Tyler, Tex.—B. W. Rowland, Superintendent, informs us that a Worthington pump and four miles of mains are being used for the extensions, which are now nearly finished.

Waxahachie, Tex.—The company has just begun the construction of works.

PACIFIC.

Wailsburg, Wash.—The following is from J. E. Abbott:

A. L. Adams has made surveys and reported that gravity works could be built for $25,000 to $30,000 and pumping works for about $18,000. A vote on issuing bonds will be taken in June.

Waterville, Wash.—It is reported that works will be built at once by the Waterville Improvement Co., of which W. R. Ballard is President. This note inadvertently appeared under California last week.

Albina, Ore.—A new reservoir or tank is to be built by the company at once.

Union, Ore.—The Council has ordered a survey for water-works, including a storage reservoir at the head of Catharine Creek. J. B. Thompson is City Clerk.

Lodi and Woodbridge, Cal.—The Bay City Gas, Water & Electric Works has filed articles of incorporation; capital, $100,000, of which G. C. Buckland holds over $98,000, and J. D. Fish and two others the remainder.

Whittier, Col.—A. L. Reed, Secretary East Whittier Land & Water Co., informs us that by July 1 they expect to be able to supply water for all purposes.

CANADA.

Galt, Ont.—Tenders will be received until April 23 for $125,000 of water-works bonds running for 30 years and bearing 4% interest. J. G. Dikes, Town Clerk, Galt, Ont.

Leamington, Ont.—The following is from J. F. McKay, Town Clerk:

The contract for works has been awarded by the town to J. H. Armstrong, Bank of Commerce Building, Toronto, who has sublet it to various parties; contract price, $12,920. A. Baird is Engineer.

ARTESIAN WELLS.

Sanders, S. C.—W. J. & J. F. Sanders have just begun to sink a well.

Denison, Tex.—The Denison City Water Co. has contracted with the American Well Works Co., Dallas, for the sinking of a well.

Couperville, Wash.—There is talk of sinking wells on Whidby's Island.

IRRIGATION.

Lebanon, Ore.—The Lebanon & Lantiam Canal Co. proposes to construct a canal to take water from the south fork of the Lantiam River, Linn Co. C. H. Ralston is one of the incorporators.

Pendleton, Ore.—The Columbia Valley Land & Irrigation Co. has been organized at Pendleton. J. M. Jones, Boise City, Idaho; N. G. Blalock, Walla Walla, Wash., and others; capital, $1,000,000. The company has bought the rights and ditches of the Umatilla Meadows & Butter Creek Canal Co. A ditch of considerable length is projected.

Santa Fe, N. Mex.—Surveys are to be made to determine the feasibility of building a reservoir for irrigation purposes.

SEWERAGE AND MUNICIPAL.

Sewers.—***Maine.***—Rockland has voted to have surveys and plans made.—Waterville will extend its sewer system throughout the Plains district this season.

Massachusetts.—North Adams proposes to have a main sewer, and an investigation has been made and plans approved by the State Board of Health. A local committee has been appointed. The sewer will be 24 × 36 ins. and 23 × 42 ins. brick and 12 to 24-in. pipe. Estimated cost, $40,000.—Beverly has had a report from a committee recommending the expenditure of $35,000, but the matter has been postponed for a year.—Quincy has had a bill passed authorizing the establishment of a sewerage system. The act must be submitted to the voters for acceptance.

Rhode Island.—Providence. An additional appropriation of $30,000 for lateral sewers has been granted to the Department of Public Works.

Connecticut.—New Haven. The city engineer has been directed to advertise for bids on new sewers.—Ansonia. About $15,000 will be spent on sewers this season.

New York.—Port Jervis. The taxpayers have voted to allow the Sewer Commissioners to build sewers at a cost not exceeding $85,000.—Jamestown. Mr. C. P. Bassett, of Newark, N. J., will submit plans for sewerage.—Rochester. A bill has been passed by the Legislature authorizing a sewerage system.—Medina. A sewer bill has passed the Senate.

New Jersey.—Plainfield has voted against issuing $350,000 in bonds, and proposes to grant a franchise for sewerage to a company.—The South Orange Sewerage Committee estimates the cost at $60,000 for sewers and $13,500 for the sewage farm. Sewerage is the leading topic in Orange, South Orange, Bloomfield and Montclair. It is proposed to have the four municipalities unite and carry a large trunk line to the Passaic River, near Belleville. This would reduce the cost to a very small amount. Mr. C. P. Bassett, of Newark, N. J., would be the engineer.—Bridgeton. Sewers are projected.—Summit. Mr. Bassett has made a proposition to lay out a system.

Pennsylvania.—Philadelphia has appropriated $88,000 for sewers in the Twenty-second Ward.

Kentucky.—Covington. Mr. Wolking has presented to the council a resolution for a trunk sewer 10 ft. diameter, to cost $125,000.

South Carolina.—Newberry is laying terra cotta pipe sewers.

Indiana.—South Bend will probably lay 2 miles of pipe sewer this year.—Anderson has adopted a sewer system, partly the combined and partly the separate system, and will lay 15¼ miles this year, varying from 8-in. pipe to 40-in. brick. Mr. H. Rawie is City Engineer.

Michigan.—Sanilac Center proposes to expend $3,000 in sewers this season.

Iowa.—Clinton. Mr. C. P Chase, City Engineer, is preparing plans for a system of sewerage. The sewage will have to be pumped.

Oregon.—Eugene.—A sewerage system is projected.

Washington.—Aberdeen is to have sewers. Address Mr. J. A. Taft.

Manitoba.—The city engineer of Winnipeg estimates an annual expenditure of $200,000 to $300,000 for sewers for the next few years.

Streets.—***New York.***—The New York Department of Public Works will lay several miles of asphalt paving.

Pennsylvania.—Pittsburg.—A considerable amount of work is being done by private contract, citizens preferring not to wait for the action of the Legislature.—York. Brick paving is suggested.

Alabama.—Montgomery has passed an ordinance providing for paving, graveling and macadamizing the streets.

Indiana.—Indianapolis will have asphalt paving on Virginia Ave., Shelby St., and other streets.

Michigan.—Bay City is said to be dissatisfied with cedar blocks and to want to try vitrified brick paving.

Illinois.—Champaign contemplates laying about 2,500,000 brick on its streets this season. Contracts have been let to Sutton & Sheldon, of Urbana, for brick, and to John Glass, of Decatur, for paving. Work will be commenced in May.

Washington.—Tacoma. The report of the street committee recommending cedar block paving for certain streets has been adopted.

Bonds.—Newport, R. I.; $70,000 for sewers and streets. Syracuse, N. Y.; $1,000,000 water bonds, proposals to be received until April 20. South Bethlehem, Pa.; Mr. Kline, of the City Council, propose to have the bonded indebtedness increased for street improvements. Asheville, N. C.; vote to be taken in May on an issue of $610,000 for streets and sewers. Oxxanna, Ala.; $20,000 for streets and

sewers. Springfield, Mo.; $200,000 for sewers, bids to be received by the City Clerk until May 5. Grand Junction, Col.; sewer bonds proposed. Roseburg, Ore.; $25,000 voted for sewers, city hall and jail. Fairhaven, Wash.; vote to be taken on issuing sewer bonds. Kent, Wash.; vote to be taken on issuing bonds for sewers. North Yakima, Wash.; $60,000 for sewers.

Sewage Disposal.—Meriden, Conn. A plan for sewage disposal by filtration and irrigation has been presented to the Sewer Committee by Mr. S. C. Heald, of Boston, and Mr. T. H. McKenzie.—Columbus, O. A senate bill has been introduced authorizing this and other cities to operate sewage farms and acquire land for this purpose.

Street Cleaning.—Sioux City, Ia. The street committee is preparing specifications for the street sweeping contracts. The contracts will be for 5 years, and will require the sweeping of 1,000 miles of streets per year.—Chicago, Ill. The street sweeping contract has been awarded to John F. Walsh at $27 per mile, or $600,000 for the year.

ELECTRICAL.

Electric Light.—New plants or extensions of existing systems are reported as probable in the following places:. Chestertown, La., address W. Eliason; Wilkesborro, N. C. address the Winston Land & Improvement Co.; Edmore, Mich.; Greenville, S. C., address the Greenville Gas, Electric Light & Power Co.; Nashville, Tenn., address D. B. Cooper; Alexandria, La., address F. M. Welch; Longview, Tex.; Russellville, Ark.; La Grange, Tex., address J. C. Brown; Kenosha, Wis.; Salisbury, Pa.; Oconto, Wis., address Citizens' Light & Fuel Co.; Sheldon, Ia., address the Sheldon Electric Light Co.; Ashland, O., address the Ashland Gas & Electric Light Co.; Stevens Point, Wis.; Langhorne, Pa.; Jacksonville, Ill.; Madison, Ga.; Union City, Pa.

Uniontown, Ala.—The City Council has voted to issue $25,000, of electric light and water-works bonds.

Pulaski, Tenn.—J. T. Oakes, City Recorder, will receive bids for a municipal lighting plant.

Vallejo, Cal.—The Trustees have decided to advertise for bids for 36 lamps of 2,000 c. p., to be placed on 40-ft. posts, with 15-ft. arms. Wires may not approach nearer than 20 ft. to the sidewalk or street. The contract will be for 5 years.

New Companies.—Belt Creek Water, Electric Light & Power Co., Great Falls, Utah; capital stock, $25,000; incorporators E. G. and J. G. Maday, I. Myers. Barnwell Electric & Power Co., Barnwell, S. C.; G. T. Bellinger, President; P. M. Buckingham, Secretary. Mason Battery & Electrical Co., Newark, N. J.; incorporators, G. G. Peck and M. Taylor, of New York; W. A. Law, of Brooklyn; H. A. Potter, of Orange; capital stock, $30,000. Niles Electric Co., Niles, Mich.; capital stock, $40,000. Shaw Electric Crane Co., Muskegon, Mich.; capital stock, $15,000. Subsurface Electric Co., Jersey City, N. J.; capital stock, $2,000,000; incorporators, W. McMahon, Rahway, N. J.; J. H. Knight, Brooklyn, N. Y.; B. Lande, New York. Philadelphia Electric Service Co., Camden, N. J.; capital stock, $100,000; incorporators, F. M. Brinley, E. W. Dwight, S. W. Wray, all of Philadelphia; Greenville, S. C., Gas, Electric Light & Power Co.; capital stock, $55,000; President, J. L. Orr; Secretary, R. R. Asbury. Texarkana, Ark., Light & Power Co.; capital stock, $125,000; incorporators, J. Deutschman, B. Collins, G. W. Fourke. Whitehall, N. Y., Electric Light & Power Co.; capital stock, $50,000; trustees, W. D. Rich, H. R. Gardner, F. Fishler. Max Meadows, Va., Water & Light Co.; capital stock, $100,000; incorporators, W. H. Boiling, J. H. Crocket, G. P. Maury. Bridgeport, Ala., Electric Light & Ice Co.; capital stock, $60,000; incorporators, A. L. Soulord, E. A. Hoffman, F. J. Kilpatrick. La Roche Electric Works, Philadelphia, Pa.; capital stock, $100,000; President, G. H. Davis; Secretary, J. F. Webb. City Electric Light Co., Charlestown, W. Va.; incorporators, W. Neill, H. D. Gibson, W. Campbell and others.

CONTRACTING.

Harbor Work.—*Sabine Pass, Tex.*—Proposals for improving the harbor have been received by Major J. B. Quinn, U. S. Engineer Office, New Orleans, La. The work includes (A) 25,000 sq. yds. of brush mattress in place; (B) 35,000 gross tons of rip-rap stone in place, and (C) 132,500 gross tons of capping blocks, weighing from 1 to 4 tons.

	A. per sq. yd.	B. per ton.	C. per ton.	Total.
C. Clark & Co., Galveston, Tex	$1.70	$3.29	$4.80	$313,650
J. F. Gayner, Fayetteville, Ky	1.75	3.45	4.91	324,075
Alabama Dredging Co., Mobile, Ala	2.05	3.80	4.90	343,500
Woodward, Wight & Co., New Orleans, La.	2.50	4.00	6.00	397,500
Wm. Z. Partello, Washington, D. C	2.10	4.50	6.50	421,250

Dredging.—*Philadelphia, Pa.*—The following proposals have been received by Major C. W. Raymond, U. S. Engineer Office, for the removal of Petty's, Smith's, and Windmill islands and the improvement of the harbor, including (*A*) about 18,000,000 cu. yds. of dredging, (*B*) removing 18,000 lin. ft. of pile and timber wharfing or revetment, and (*C*) depositing and spreading 2,500,000 cu. yds. of material on League Island. The bidders are all Philadelphia firms, and the contract has been awarded to James A. Mundy & Co.:

	A. per cu. yd.	B. per lin. ft.	C. per cu. yd.	Total.
J. A. Mundy & Co....	10¾ cts.	$1.99	9½ cts.	2,229,200
American Dredg. Co.	15⅛ "	1.99	23¾ "	3,417,950
Penn. Dredg. Co.....	16¾ "	2.25	24½ "	3,698,000

Street Work.—*Montgomery, Ala.*—The contract for 21,000 sq. yds. of paving has been awarded by Mr. D. W. Ford, City Engineer, to Venable Bros., of Atlanta, Ga., at $2.24 per sq. yd. for granite block pavement on broken stone foundation without bituminous cement joints. Their bids for such pavement on foundations of different kinds, with and without bituminous cement joints, were as follows: (the figures in brackets are the bids of the Southern Granite Co., of Atlanta, Ga.): on hydraulic cement concrete, made with broken stone, $3.51 and $3.20, ($3.82 and $3.42); on concrete made with furnace slag, $3.15 and $2.85 ($3.72 and $3.32); on concrete made with gravel, $3.06 and $2.75, ($3.62 and $3.22); on brok en stone, $3.14 and $2.24, ($3.27 and $2.87); on furnace slag, $2.83 and $2.53, ($3.17 and $2.77); on gravel, $2.60 and $2.30, ($3.07 and $2.67). The prices on other work were as follows: 5-in. granite curb, 60 cts. ($1.15) per lin. ft.; granite crossings, 70 cts. (80 cts.) per lin. ft.; resetting curbs and crossings, 10 cts. (5 cts).

Milwaukee, Wis.—Contract has been let for granite block paving at $2.35 and $2.40 per sq. yd.

Pipe and Castings.—*Washington, D. C.*—The District Commissioner has awarded the contract for cast-iron water pipe to the Camden Iron Works, of Philadelphia, Pa., $26.95 and $27.15 per ton for 6-in., $26.74 for 16 and 20-in., $2.45 for castings. Another contract has been awarded to D. S. B. Clew, of New Jersey, at $26.75 for 12-in. pipe and $2.49 for castings.

Sewers.—*Westfield, Mass.*—The contract for constructing about 15,000 to 20,000 ft. of pipe sewer has been awarded to T. Marsden, of Utica, N. Y.

PROPOSALS OPEN.

Sewers.—*Providence, R. I.*—Sections 6, 7 and 9 and on 3 streets; about 21,000 ft. Robert E. Smith, Commissioner of Public Works. May 7.

Newark, N. J.—Vitrified pipe 12 and 15-in.; 23¼ × 27 ins. brick; manholes and basins; 3 contracts. John Hunkele, Street Commissioner. April 22.

St. Louis, Mo.—In 5 districts; separate contracts; 12, 15, 18 and 21-in. pipe; 21 × 36 in. to 51-in. brick. The Board of Public Improvements. April 24.

Streets.—*Louisville, Ky.*—About 10,000 tons of granite paving blocks. Henry S. Tyler, Mayor. May 22.

Springfield, O.—Brick paving, curbing, etc. The City Clerk. May 9.

Avondale, O.—Grading, guttering and macadamizing Spring St. M. D. Burke, engineer, Pike's Building, Cincinnati, O. May 4.

Highways.—*Adamstown, Md.*—Turnpike, 3½ miles long, 20 ft. wide, 14 ft. covered with 9 ins. of limestone. George T. Kohlenberg. May 1.

Yellowstone Park.—About 25 miles of wagon roads. Major W. A. Jones, U. S. Engineer Office, Globe Building, St. Paul, Minn. April 25.

Bridges.—*Centralia, Wash.*—Highway bridge over the Chelalis River. The Lewis Co. Commissioners. May 7.

Cincinnati, O.—Wrought iron truss bridge, with abutments and wing walls, across West Fork of Mill Creek. The Hamilton Co. Commissioners. April 25.

South Yarmouth, Mass.—Across Bass River. T. T. Hallett, Yarmouthport, Mass. April 25.

Huntington, Ind.—Stone abutments for 2 iron bridges over Little River. The Huntington Co. Commissioners. April 28.

Minnedosa, Man.—Iron bridge over the river on Main St., masonry, etc. R. H. Myers. May 1.

Railway.—*Philadelphia, Pa.*—About 1 mile of pneumatic tube plant. Pneumatic Railway Co., 607 Chestnut St.

Water-Works' Supplies.—*Cincinnati, O.*—Machine shop castings, furnaces, street valve boxes, iron pipe and specials, brass castings and ferules. The Board of Public Improvements. April 30.

Sewer Pipe.—*Dayton, O.*—About 14,000 ft. of 18-in. vitrified salt glazed pipe. J. B. Thomas, Governor, National Military Home. April 25.

MANUFACTURING AND TECHNICAL.

Locomotives.—The Baldwin Locomotive Works, of Philadelphia, Pa., have shipped 27 locomotives to New South Wales for the government railways. They have built 10 engines, including 3 consolidation freight engines, for the Mexican Interoceanic and several for the Bellingham Bay & British Columbia. The Schenectady Locomotive Works, Schenectady, N. Y., built during March 30 ten-wheel engines, 1 mogul and 4 six-wheel switch engines. The Pittsburg Locomotive Works, of Pittsburg, Pa., have built 2 engines for the Pittsburg & West Virginia. The Rhode Island Locomotive Works, of Providence, R. I., have built for the Narragansett Pier road an eight-wheel engine with cylinders 17 × 24 ins., 60-in. driving wheels, weighing 90,000 lbs., with a 60,000-lb. tender. The Lima Machine Works, of Lima, O., have built a Shay geared engine for the Utah Central, to work on a 6% grade; it weighs 40 tons. The Delaware, Lackawanna & Western has built a passenger engine at East Buffalo. The Roanoke & Southern has purchased 2 engines.

Cars.—The Wagner Car Co., of Buffalo, N. Y., is building 2 private cars; Mr. Bissell, the manager, has patented a new vestibule device. The Mt. Vernon Car Co., of Mt. Vernon, O., is building 400 refrigerator cars for the Union Refrigerator Transit Co., of St. Louis, Mo., and has an order for 200 box cars. The Dayton Mfg. Co., of Dayton, O., has an order for lamps, etc., for a state car for the Governor of New South Wales. The Columbus, Hocking Valley & Toledo will build 300 coal cars. The Roanoke & Southern has purchased 2 passenger cars. The Ohio Falls Car Co. has built 10 passenger cars for the Louisville Southern.

Car Works.—The business of Schall & King, car builders, York, Pa., is now combined with that of the Middletown Car Works; Mr Arthur King is the proprietor; railway and mining cars are built. The Pullman Palace Car Co. has purchased a site for car works at St. Louis, Mo. The Virginia Car Co., of Glasgow, Va., has been incorporated; President, Col. A. S. Buford, of Richmond; capital stock, $100,000. The Board of Trade, of Haverhill, Mass., has received a proposition to establish car works in that town. The New Jersey Central has purchased land for car works at Elizabethport, N. J.

Rolling Mill.—The Berlin Bridge Co., of East Berlin, Conn., will build a rolling mile for the Washburn & Moen Mfg. Co., at Waukegan, Ill. It will be of steel, 400 × 140 ft., with wings 160 × 40 and 100 × 40 ft.

Sale of Works.—The iron and brass works of James Flower & Bros., at Detroit, Mich., established in 1856, and now in running order, are to be sold to close an estate. Bids will be received until May 10, by the firm or by W. A. Moore, Detroit.

Graphite Paint.—The Jos. Dixon Crucible Co., of Jersey City, N. J., states that its paint will resist acids and alkalies and last for 10 or 15 years, while the life of an ordinary roof or outside paint is from 2 to 5 years.

Machinery.—F. W. Iredell, of New York, N. Y., reports sales of 3 Corliss engines of 80, 300 and 400 HP., 3 air compressors, 2 locomotives, 14 boilers, steam shovel, crusher, drills, wrought-iron pipe and wire rope.

Companies. Western Steam & Street Railway Equipment Co., of Chicago, Ill.; incorporators, John S. Methot, Luther M. Tracy and Charles T. Farson; capital stock, $100,000. West Point Iron Works, of West Point, Ga.; incorporators, E. F. and W. C. Lamar; capital stock, $50,000. Trojan Car Coupler Co., of Troy, N. Y.; incorporators, F. S. Young, of Troy; Geo. C. Thomas and C. P. Anderson, of New York; capital stock, $300,000. Leland Car Heater & Steam Coupler Co., of New York; capital stock, $40,000. Gardner Steam Pump Co., of Quincy, Ill., incorporators, Robert Gardner, J. W. Gardner, and J. C. Neustadt; capital stock $50,000. Steele Signal Co., of Chicago, Ill.; incorporators, Charles Higgins, H. W. Powers and R. E. Davidson; capital stock, $1,000,000. Sheboygan Dredge & Dock Co., of Sheboygan, Wis.; President, Ole Groh; capital stock, $50,000. Portland Bituminous Paving & Improvement Co., of Portland, Ore.; incorporators, E. J. Jeffrey, John Bays and David Steel; capital stock, $100,000. National Water Supply & Guarantee Co., of Ashland, Ky., General Manager, J. M. Gardiner. Terminal Improvement Co., of New York; incorporators, H. Walter Webb, John E. Searles, Jr., and Wm. Rossitter; capital stock, $60,000. Whatcom Co. Road & Building Co., of Whatcom, Wash.; capital stock, $75,000.

Metal Market Prices.—*Rails.*—New York: $30.75 to $31.25; old rails, $24.50 for iron and $17 for steel. Pittsburg: $30 old rails, $24 to $24.25 for iron and $17 to $17.50 for steel. Chicago: $31; old rails, $23.25 for iron and $17 for steel.

Track Materials.—New York: steel angle bars, 1.75 to 1.8 cts.; spikes, $1.9 to $1.95; track bolts, 2.75 cts. with square, and 2.9 cts. with hexagon nuts. Pittsburg: splice bars, 1.9 to 2 cts. for iron or steel; iron or steel spikes, 2.05 cts.; iron track bolts, 2.8 cts. with square, and 2.9 cts. with hexagon nuts. Chicago: splice bars, 1.85 to 1.9 cts. for iron, 2 to 2.05 for steel; spikes, 2 to 2.1 cts.; track bolts, 2.85 cts. with hexagon nuts.

Foundry Pig Iron.—New York: $14 to $16. Pittsburg: $14.75 to $16. Chicago: $14.50 to $16.

Pipe.—Cast iron, $25 to $30 per ton. Wrought iron, discounts as follows, at Pittsburg: 57½ and 50 per cent. on black and galvanized butt-welded; 67½ and 55 on black and galvanized lap-welded. Casing, 55 per cent.

Lead.—New York: 4.25 to 4.3 cts. Chicago: 4 to 4.05 cts. St. Louis: 4 to 4.05 cts.

Structural Material.—New York: beams, 3.1 cts.; channels, 3.1 cts.; angles, 1.95 to 2.1 cts.; tees, 2.45 to 2.75 cts.; sheared iron plates, 2 to 2.25 cts.; steel plates 2 to 2.15 cts. for tank, 2.35 to 2.6 cts. for shell, 2.6 to 2.7 cts. for flange, 3.75 to 4.25 cts. for firebox. Pittsburg: beams, 3.1 cts.; channels, 3.1 cts.; angles, 2.05 cts.; tees, 2.85 cts.; universal iron mill plates, 2.1 cts.; sheared steel bridge plates, 2.3 cts.; refined bars, 1.85 to 1.9 cts.; steel plates, 2.2 cts. for tank, 2.55 cts. for shell, 2.75 cts. for flange, 4.25 to 4.5 cts. for firebox. Chicago: beams, 3.2 cts.; channels, 3.2 cts.; angles, 2.25 to 2.5 cts.; tees, 2.7 to 2.85 cts.; universal plates, 2.3 to 2.4 cts.; sheared plates, 2.5 to 2.6 cts. for iron and 2.6 to 2.7 cts. for steel; steel plates, 2.6 to 2.7 cts. for tank, 3.25 cts. for shell, 3.5 cts. for flange, 4.25 to 5.5 cts. for firebox; boiler rivets, 4 to 4.25 cts.